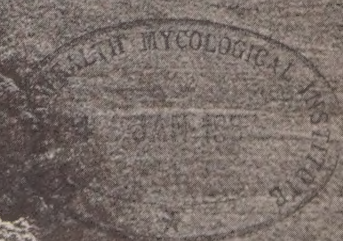
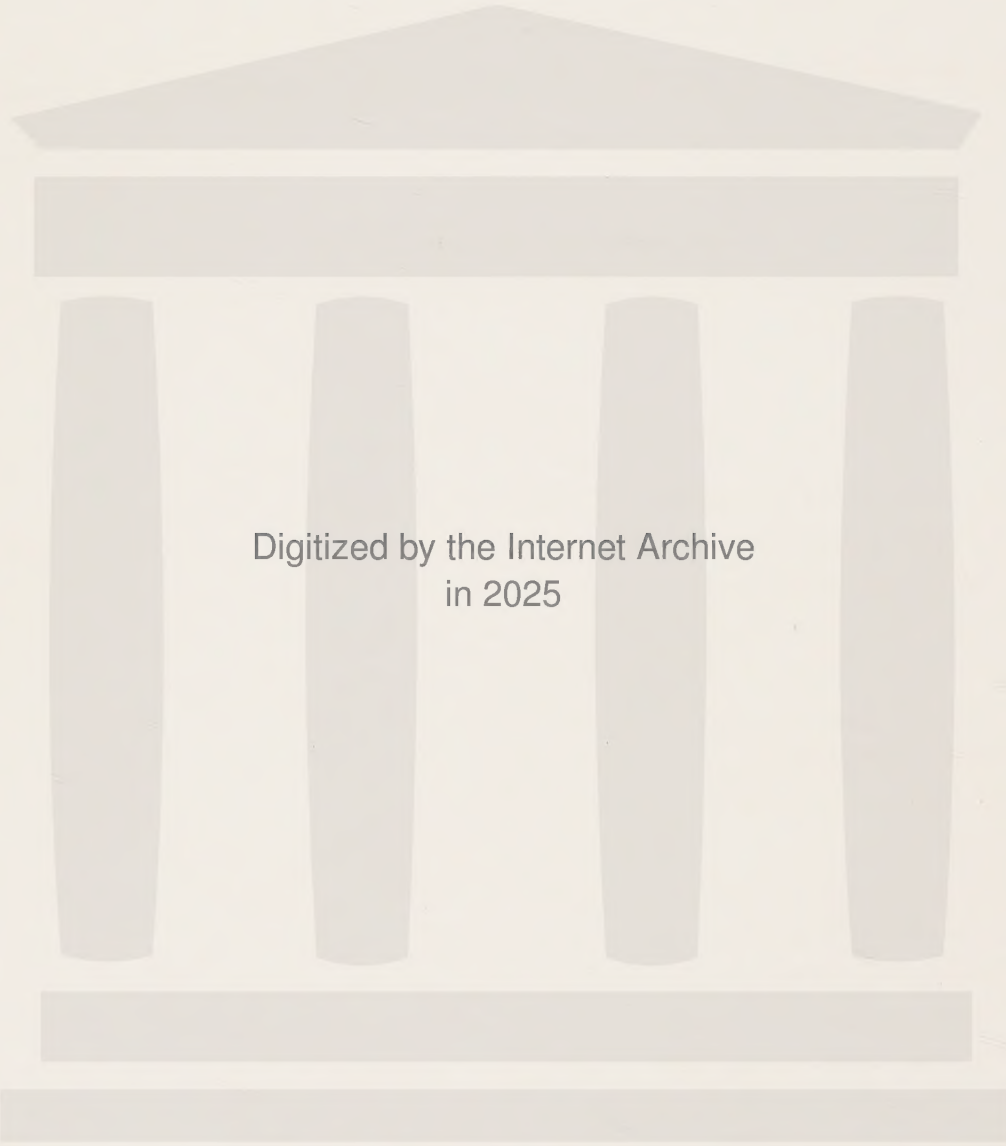


EXPERIMENT STATION COMMITTEE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

1956 *Report*





Digitized by the Internet Archive
in 2025

THE COMMITTEE IN CHARGE

THE EXPERIMENT STATION

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

REPORT

October 1, 1955 to September 30, 1956

CONTENTS

LETTER FROM EXPERIMENT STATION COMMITTEE.....	1
LETTER FROM THE STATION DIRECTOR.....	3
CULTURAL PRACTICES	5
DISEASES	23
FACTORY	28
INSECTS	32
MECHANIZATION	35
ORGANIC CHEMISTRY	39
VARIETIES	42
WATER DEVELOPMENT	51
WEATHER	55
WEED CONTROL	59
YIELD DECLINE	68
TRAINING OF PERSONNEL.....	70
EXPERIMENT STATION STAFF.....	72
STATION PERSONNEL CHANGES.....	74

On the Cover:

Trash left in the fields (lower left)
lessens the damage done by heavy rains
on the Hilo Coast. See page 18.

To the President and Members

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

Gentlemen:

The accomplishments of the Station for the year 1956 are very ably presented to you in the Annual Report of the Director. We sincerely hope that you will find the report of interest and value. The cooperative work with various agencies and institutions has materially aided us all in a clearer understanding of the problems we still face in agriculture, in the factory, and in by-product utilization.

We feel that as a result of the establishment of a new classification system and the review of various policies on employee welfare, we now have a greater knowledge of our staff. We also feel that they in turn have a clearer understanding of their part in the organization and their future.

Once again we express our appreciation for the assistance rendered by the various Island Planters' Associations, their representatives, and the Technical Advisory Committees in carrying out the work of the Station Committee and of its Director. A survey has been carried out on the operations of the industry in field and factory to show what we know and where deficiencies still exist in our Research Program. This should soon be available for study by those interested.

We feel that the money spent this year has resulted in excellent returns and recommend your kind attention to the Report of the Director which reviews the accomplishments for 1956.

Respectfully submitted,

W. W. G. MOIR,
Chairman

EXPERIMENT STATION COMMITTEE

EXPERIMENT STATION COMMITTEE

W. W. G. MOIR, *Chairman*

F. W. BROADBENT
W. M. BUSH

R. A. COOKE, JR.
F. A. SCHAEFER III

Associate Members

J. W. ANDERSON
JOHN CUSHNIE
A. D. EDNIE

A. J. HEBERT
W. M. MORAGNE
F. E. SIMPICH, JR.

H. A. WALKER, JR.
A. R. GRAMMER,
Secretary

ADVISORY COMMITTEES OF THE STATION COMMITTEE

Field Engineering

H. A. WALKER, JR.,
Chairman
C. H. AHLF
B. B. ALEXANDER
A. J. HEBERT
MALCOLM MACNAUGHTON
R. M. FRAZIER
R. C. WILLIAMSON
K. H. BERG
E. B. HOLROYDE
L. D. BAVER

Factory Engineering

A. J. HEBERT,
Chairman
WM. BOMKE
W. J. HULL
W. KENDA
R. G. WATT
A. T. HOSSACK
L. M. VAN DRESER
G. W. TOMPKIN
J. N. ORRICK
L. D. BAVER

By-Products

F. E. SIMPICH, JR.,
Chairman
A. J. HEBERT
W. KENDA
W. W. G. MOIR
F. A. SCHAEFER III
C. E. S. BURNS, JR.
ALAN E. FAYE
F. C. CHURCHILL
R. JOHNSTON
L. D. BAVER

To the Experiment Station Committee

Gentlemen:

The accomplishments of your Experiment Station for the year ending September 30, 1956, are clearly portrayed in this Annual Report which we submit to you. It has been a year of notable progress.

The Department of Experimental Statistics was reorganized as a cooperative department with the Pineapple Research Institute. J. G. Darroch, statistician for the Agricultural Experiment Station of Washington State College, was appointed Head of the Department and joined the staff on April 1, 1956.

The name of the Department of Agricultural Engineering was changed to Field Engineering. Three project engineers, W. P. Burton, C. B. Holtwick, and E. P. Morgan, along with three new draftsmen, joined the staff to concentrate on the solution of mechanical harvesting problems. Professor George E. Pickard of the Department of Agricultural Engineering of the University of Illinois is spending his sabbatical leave with the department advising the Experiment Station concerning problems of organization, research procedures and mechanization.

A new research project for studying sugar quality was initiated in the Department of Sugar Technology. Dr. Chen-Chuan Tu joined the staff on September 1, 1956, to become project leader. G. F. B. Appel, a mechanical engineer, also was added to the staff of the department on September 1 to investigate problems associated with milling.

Dr. Karl Hamner, Head of the Department of Botany, UCLA, spent four months of his sabbatical leave with the Station studying the problem of the physiology of flowering, which is his specialty. He also gave a series of seminars on the subject.

R. H. Van Zwaluwenburg, Head of the Department of Entomology, retired on April 30, and F. A. Bianchi was appointed as his successor. R. E. Warner became Assistant Entomologist on July 1.

J. B. Menardi retired as Associate Island Representative on May 31, 1956.

The mauka irrigated variety substation was moved from Waimanu, above Pearl City on Oahu, to McBryde Sugar Company on Kauai. A task force to assist in the harvesting of experimental plots on Kauai became part of the new responsibilities of the Island Representative, along with the operation of the new substation.

The Director, with the assistance of a committee from the staff of the Station and members of the Classification Committee of the agencies, developed a classification system for Station personnel along lines in use in the industry. Fourteen classifications were set up and approved by the Experiment Station Committee.

A scholarship program was inaugurated as a talent search for competent Island boys to enter the Factory Engineering trainee program. The program consisted of annual grants for college training and summer jobs in plantation factories. One senior, two juniors, two sophomores and two freshmen were appointed. The competition among 76 applicants was very keen. Dr. E. L. Hood and his staff of C. Brewer and Company assisted in the screening of applicants.

Dr. A. J. Mangelsdorf represented the Experiment Station and the Hawaiian sugar industry at the Ninth International Congress of Sugar Cane Technologists that was held in India in January and February 1956. The Tenth Congress will be held in Hawaii in May 1959. Your Director has been named General Chairman. W. W. G. Moir, present Chairman of the Experiment Station Committee, is General Secretary-Treasurer.

Dr. J. N. Warner attended the Symposium on Genetics and Plant Breeding held in May at the Brookhaven National Laboratory in Long Island.

Rokuro Urata, Senior Geneticist, attended the International Genetics Symposia held in Tokyo in September.

The cooperative research project with the Imperial College of Tropical Agriculture in Trinidad has produced some very significant results on the ammoniation of the pith of bagasse as a source of protein equivalent for cattle feed. The pith not only becomes more palatable, but apparently more digestible. Dr. L. F. Wiggins is leaving Trinidad on October 1, 1956. Dr. H. Wayne Hilton, Principal Organic Chemist, visited the Imperial College in September to obtain a first-hand report on the research on cane by-products.

During the year, 1,174 volumes were added to the Library, as well as 102 new serial titles. There were 2,100 books loaned, of which 300 were borrowed by other than staff members.

All staff changes taking place during the year are listed on page 74.

Respectfully submitted,

EXPERIMENT STATION, HSPA

L.D. Baver

Director

CULTURAL PRACTICES

AQUA AMMONIA INJECTION GAINS MOMENTUM

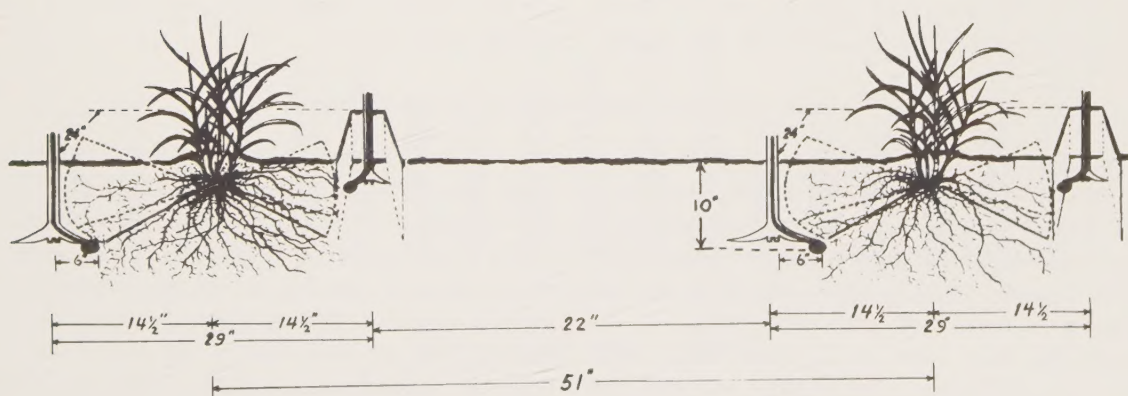
Although the bulk of the nitrogen purchased as aqua ammonia in 1956 is still applied in irrigation water, there was a sizeable increase in the quantities applied by injection equipment both on unirrigated and irrigated plantations. Applications by injection equipment are proving most satisfactory. Improvements have been made in application equipment to ensure a better placement. Figures 1 and 2 show the placement of aqua ammonia in unirrigated ratoons by Kohala Sugar Company equipment. Bands of ammonia are released on both sides of the stools at a depth of approximately 10 inches and at a distance of eight inches from the center of the cane lines. This placement close to the zone of maximum concentration of roots ensures maximum efficiency from the nitrogen applied. Under irrigated conditions, wider spacings must be used since the injection operation is followed by line reshapers. Waialua Agricultural Company is successfully using injection placements at 19.5 inches from the center of the lines. Improvements have also been made with the equipment applying aqua ammonia in relatively shallow positions behind swept-back shanks

in the wetter unirrigated districts. Changes were made to obtain a deeper coverage and minimize volatilization losses.

Volatilization losses of surface-applied aqua ammonia vary from 8 to 19 per cent in acid soils. Placement at shallow depth reduces the losses considerably. Injections at depths ranging from four to 10 inches, varying with rooting patterns, are recommended to minimize volatilization losses and ensure maximum utilization. Volatilization losses from injection operations in alkaline soils (Figure 3) may run as high as 60 per cent, when applied in concentrations of 1500 ppm, but are negligible when injected at rates of 500 ppm.

Rates of nitrification of injected aqua ammonia have been studied on four soils ranging in pH from 5.0 to 8.1. Results of controlled studies show nitrification to be retarded temporarily at the higher rates of application (Figure 4). The ammonia kills the nitrifying bacteria in the band and thus retards its conversion to nitrate nitrogen. It also causes a dispersion of aggregates which seals pores through which water moves and reduces infiltration rates. In controlled studies, irrigation

Figure 1. Aqua ammonia placement at Kohala Sugar Company.



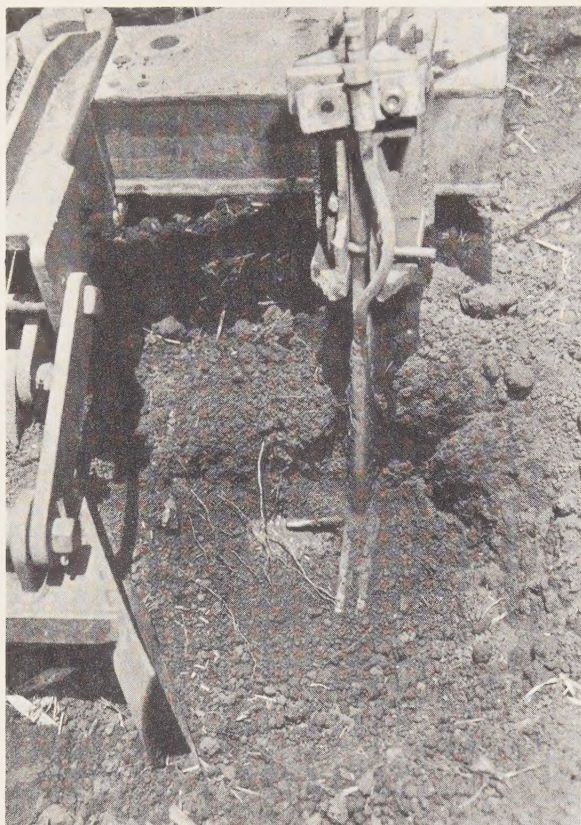


Figure 2. Application of aqua ammonia, at the rate of 175 pounds nitrogen per acre, close to stools at ratooning time. Kohala Sugar Company.

water containing varying amounts of aqua ammonia and ammonium sulfate was leached through soils under a hydraulic pressure gradient of two. When compared with the checks, there was more than twofold difference in time required to pour six inches of water containing 30 ppm nitrogen as aqua, more than threefold difference for 12 inches, and fourfold difference for 18 inches. The perme-

SOIL COMPACTION STUDIES PROGRESSING

Compaction tests establishing the critical densities where cane roots fail to operate normally, have been completed on several of the principal sugarcane soils. Soils of the Lahaina family, low humic latosols, show no root distortion and no evidence of restricted root distribution at 65 pounds per cubic foot. At 72 pounds per cubic foot, root distribution was slightly reduced, but

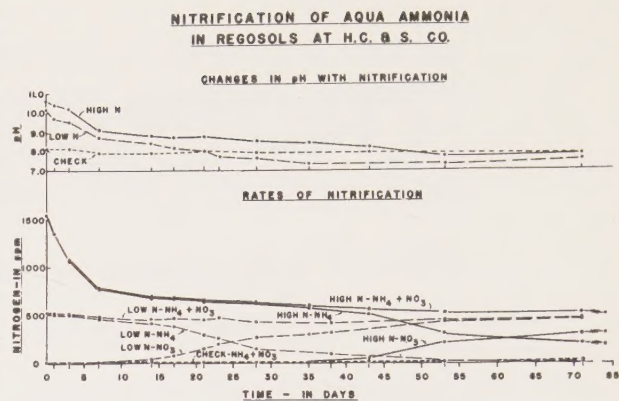


Figure 3.

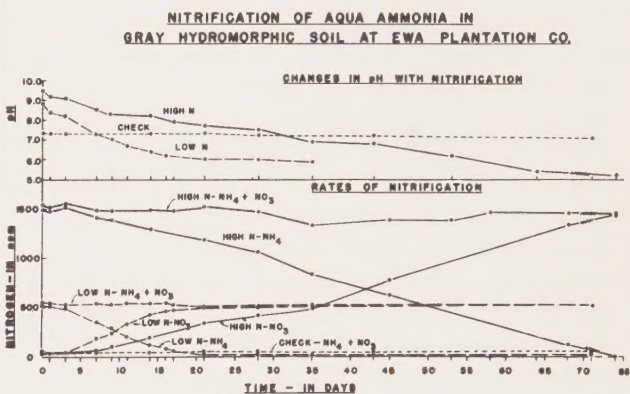


Figure 4.

ability was not affected by the presence of ammonium sulfate in the irrigation water.

Field studies of rates of nitrification of aqua ammonia applied in irrigation water show variable results. Under optimum conditions of moisture and temperature, nitrification was completed in six days, while in other tests it was only half completed in one month.

was still reasonably satisfactory at 78 pounds per cubic foot. Examination of the branching of rootlets revealed a tendency toward angular turning and a slight flattening of rootlets. At 85 pounds per cubic foot, rootlet distribution was reduced and the distortion to rootlets more evident. Ninety-one pounds per cubic foot is the critical density that will seriously reduce root penetration. Roots

detoured the compacted block; those which did penetrate, became flattened. At 97 pounds per cubic foot, very few roots were able to penetrate.

Observations of the presence of distorted roots in a given density of soil did not prove that the roots were functioning normally. Radioactive rubidium placed in the centers of the compacted cores was taken up by the distorted roots, indicating that they were operating to some degree.

Since field compaction is not uniform and since the denseness of compacted soil decreases with depth, a prediction of depth-of-tillage requirement can be made from root studies of this type.

The effects of ground pressure on extent and depth of soil compaction have been studied on a number of soils under variable moisture conditions. The effects of soil moisture on the force required to obtain a density of 95 pounds per cubic foot is presented in Figure 5.

Ground pressure exerted by Tournahaulers at Hawaiian Commercial & Sugar Co., Ltd. applies a force in the neighborhood of 85 pounds per square inch. The Molokai soil must have a moisture content of 26 per cent before Tournahauler traffic will result in critical densities. The effects of additional traffic on the depth and degree of compaction are being studied in relation to tire inflation, tread design, and degree of tire wear.

The effects of compaction at different moisture levels on porosity and air percentage by volume are shown in Figure 6.

GROUND PRESSURE - SOIL MOISTURE RELATIONS
NECESSARY FOR
COMPACTION OF 95 LBS./CU. FT.
FOR FOUR SOILS FROM H.C.B.S. CO.

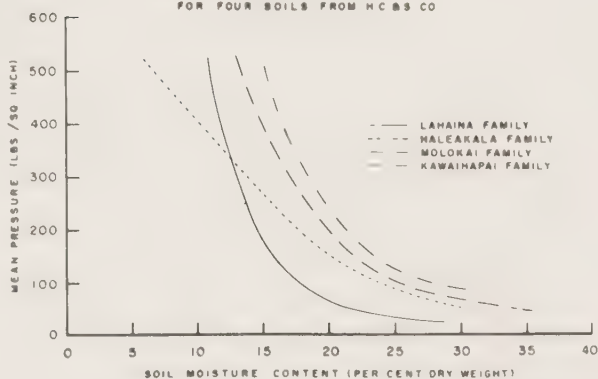


Figure 5.

As the apparent density increases to the critical density for sugarcane roots, the total pore space decreases to slightly less than 50 per cent. The air percentage by volume decreases rapidly to approximately 10 per cent as density increases to the critical level.

Three of the principal soils on which sugar cane is grown were selected for comprehensive testing at the U. S. Tillage Laboratory at Auburn, Alabama, where A. C. Trowse of the Department of Agronomy is pursuing graduate study. They represent the hydrol humic, gray hydromorphic, and low humic latosols from Onomea Sugar Company, Ewa Plantation Company and Oahu Sugar Company, Ltd.

EFFECT OF COMPACTION ON POROSITY

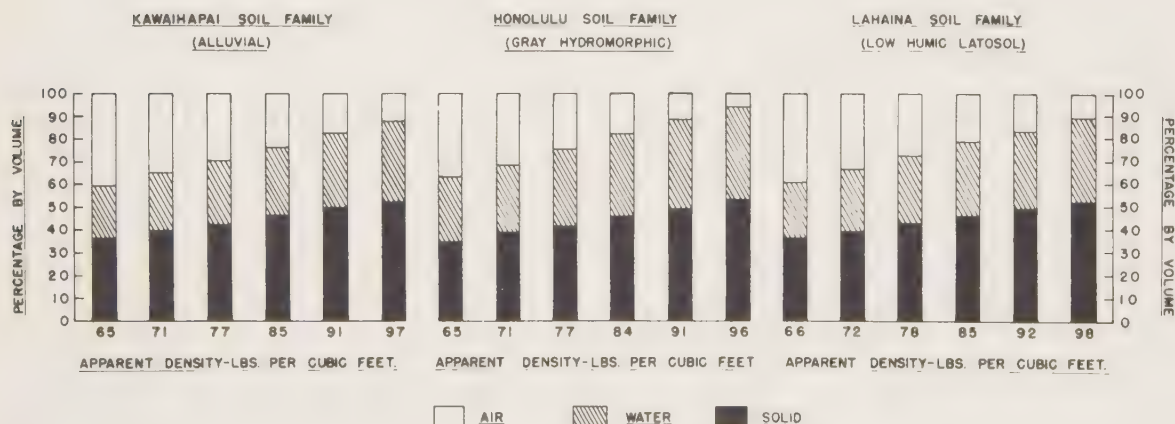


Figure 6.



Figure 7. Broadcast application of raw rock phosphate at 1500 pounds per acre in mauka fields.

At Lihue



Figure 8. Deep plowing to depths of 20 to 22 inches with Towner plow.

DEEP PLOWING ADVOCATED FOR BETTER ROOT SYSTEMS

Shallow rooting has been blamed for low yields in many mauka areas of shallow surface soil. Relatively shallow tillage in previous years has not encouraged deeper rooting of the cane. Phosphate levels of the underlying subsoils are often critically deficient. Even deep subsoiling operations have failed to incorporate appreciable subsoil in the surface soil in an effort to increase the depth of rooting.

The Lihue Plantation Company, Ltd. initiated studies early last year in deeper tillage. Rock phosphate was broadcast at the rate of 1500 pounds per acre and incorporated to a depth of 21 to 23 inches with a Towner disk plow (Figures 7 and 8). The subsoils of several fields in the Hanamaulu section have practically no available phosphorus.

Root studies of year-old cane exposed beautiful root systems extending to depths of 22 to 24 inches (Figures 9 and 10). The more extensive root systems feeding from a larger volume of soil should support a larger cane tonnage, particularly during periods of drought.

The broadcast application of rock phosphate on phosphorus-deficient, acid soils, makes possible

the removal of most of the bulky phosphate fertilizer from the planting machines, to make room for aqua ammonia equipment.

The Barrett disk plow, operating with a Caterpillar D-9 tractor, did a commendable job of plowing at Oahu Sugar and Waialua. The five 52-inch disks were plowing to depths of approximately 20 inches and covering an average of 1.63 acres per hour. The D-9 pulling an Ateco rock ripper at Waialua did not increase the depth of tillage over that obtained with a D-8 tractor in previous tests. However, increased granulation in the compacted infield roadways resulted from the higher and more constant speed.

In tillage studies on the Hamakua Coast, relatively shallow plowing with a 32-inch Stockton-Davis disk plow was compared with the deeper plowing of the Storey plow. The Storey plow tilled five inches deeper than the disk plow, resulting in a 50 per cent increase in tillage depth. In the soils of the middle and makai belts, cane roots were observed to have difficulty in penetrating below the depth of tillage. These studies indicated a need for reduced post-tillage infield traffic to retain as good a root bed as is possible.



Figure 9. Root systems of 17-month old 39-7028 at Lihue, with 1500 pounds raw rock broadcast and Towner-plowed, plus 200 pounds P_2O_5 with seed at planting.



Figure 10. Root systems of 17-month old 39-7028 confined to surface soil at Lihue. Restricted rooting due to shallow tillage and critical phosphorus deficiencies in the subsoil.

SOIL RESERVES IN CANE NUTRITION

Harvest data from Grade A field experiments continue to substantiate the critical levels established for the available nutrients in the soil. Soil analyses continued to be an important guide in

plantation fertilization practices. Twenty of the 28 plantations submitted 3900 soil samples for analyses. Most of the remaining eight have occasional samples from problem areas analyzed.

INTEREST IN LIMING INCREASING

Tests harvested in 1949-1951 on windward Hawaii plantations showed superphosphate to be superior to ammophosphate as a source of phosphorus. The results were interpreted as being due to a possible shortage of calcium. Tests were then installed with calcium equalized from calcium sulfate, since this was the form of calcium in superphosphate. Gypsum was also used since this form would supply the calcium needed without appreciably altering the pH of the soil. The harvests of these later tests have proved that calcium is needed in many highly-leached soils. Soil analyses have shown fairly large acreages on Hawaii and Kauai to be low in available calcium and magnesium.

Harvest results of 19 calcium tests show the

critical level of exchangeable soil calcium to be 100 ppm for the low-volume-weight soils. Yield increases of approximately two tons sugar per acre have been obtained when the soil calcium falls below 50 ppm. A summarization of leaf sheath calcium data supports the previously defined adequate level of .15 per cent in the boom stage of growth.

Agricultural ground coral, which grades excellent in terms of total neutralizing power, is now being handled in bulk and applied as broadcast applications prior to plowing.

Since exchangeable magnesium levels in the more highly-leached soils analyze low, tests were installed to determine yield response and to define critical levels in the soil and in plant tissues. Above

50 ppm magnesium, there appears to be no observable response to treatment. At 30 ppm, applications result in improved cane growth during

the boom stage. Dolomitic limestone is under trial where both calcium and magnesium levels in the soil are low.

AERIAL FERTILIZATION EXPANDING

The industry's aerial fertilization program continues to expand as evidence accumulates in support of heavier fertilization and adequate plant food for the second season's growth. In 13 field experiments over the past three years of testing extra second season fertilization, four gave statistically significant gains over plantation practice. The average yield increase over the checks was 0.9 tons sugar per acre.

Even though significant increases in sugar yields have resulted from additional fertilizer applied as late as 5.5 months prior to harvest, it is becoming increasingly evident that poorer quality juices result from high and late application of nitrogen. Stalk census studies, crop and stalk log data support the recommendations that the last application of fertilizer be made not later than the fourteenth month of a 24-month crop. On unirrigated plantations, where withholding water for ripening purposes is not possible, the last application is generally scheduled by 12 months of age. Stalk logging is permitting a more reliable estimation of second season fertilizer requirements, and as more experience is gained in its use, there should be less need for the very late applications.

Spot fertilization by airplane is now plantation practice on several plantations. Yields of cane and sugar from knolls and other poor spots have for years pulled down field averages. In hilly lands under heavy rainfall, marked color variations from

deep green to yellowish green warn of variable yields at harvest time. Considerable attention has been focused on the benefits of differential fertilization in the past few years. Spot fertilization, or heavier applications to the poor growth areas, has maintained a more uniform color throughout the growing period, and the fields have ripened more uniformly without the extremes of lush-growing cane in the hollows and dead or dying cane on the knolls.

Spot fertilization in irrigation water is not generally feasible. Differential fertilization by machine is not practical with most of the equipment used today. Spot fertilization by hand can be done successfully, but is doomed to failure because of the high costs involved. Initial trials of spot fertilization by airplane at Kohala and Olaa Sugar Company, Ltd., looked so promising that this procedure has been adopted on several plantations. Whenever fields develop spots which are off-color, the areas are marked on a field map and the pilot is charged with the responsibility of applying the fertilizer without flagmen. Spot fertilization by airplane is now being used for treatment of knolls with thin surface soils, of depressions where a high water and inadequate drainage table limit root development, of sections of irrigated cane where applications in water have not given satisfactory fertilizer distribution, and of many other problem areas.

POTASSIUM LEVELS AT HARVEST AFFECT JUICE QUALITY

Several amounts-of-potash experiments harvested in recent years have shown juice quality to improve with each increment of potash fertilization. Nitrogen in 8-10 preharvest samples has a highly significant negative correlation with purity of the juices. It is probable that excess nitrogen will be utilized in the later months of growth if an

adequate supply of potassium is available.

Where very low levels of 8-10 stalk potassium were found in cane approaching harvest age, tests were installed on several unirrigated plantations applying 122 pounds K_2O per acre by airplane. Preliminary results indicate slight improvement in juice quality and fewer tons cane per ton sugar.

CROP LOGGING TECHNIQUES REVIEWED

Comprehensive studies in the evaluation of crop logging procedures have included an intensive review

of the crop logging practices of the four plantations that had several years of experience prior

to its adoption by the rest of the industry, and the experience of all plantations since 1950. Crop logging and stalk logging procedures have been followed on hundreds of cooperative field experiments in the past four years. The analysis of all data indicates that stalk logging offers a more sensitive and reliable index of subsequent fertilizer requirements for the growing crop.

Recommendations were made to the Theo. H. Davies & Co., Ltd. plantations to initiate stalk logging control, since these plantations, with the exception of Kaiwiki Sugar Company, Ltd., did not have previous experience with crop logging. Olaa also adopted stalk logging when they resumed agricultural research activities, since they no longer had continuity in their logging program.

The following recommendations are made for 8-10 and basal stalk logging:

1. that 8-10 and basal samples be collected as soon as sufficient growth permits, usually at five

and one-half to seven months of age; that sampling proceed at approximately two-month intervals so that four samples will be collected prior to the last application of fertilizer.

2. that no logging be practiced after the last application of fertilizer until the crop is 18-20 months of age. At this time, stalk census studies should be initiated and continued at intervals of two months until the fields are considered candidates for harvest. 8-10 preharvest sampling for moisture, nitrogen, potassium, reducing sugars and sucrose, will classify the field's readiness for harvest. Those fields more nearly ready for harvest should be sampled at closer intervals to make the final selection of the order of fields for harvest.

This modification of crop logging practices will supply the information required at a considerably lower cost than that incurred by presently used procedures. Studies are continuing and further modification may be forthcoming as more is learned about the nutrient requirements of cane.

"WONDER CHEMICAL" GIBBERELIC ACID INCREASES GROWTH RATE OF SUGAR CANE

Samples* of gibberellic acid were first used on sugar cane to test its effect on elongation of young plants grown from single-eye seed pieces in black sand. Of 10 well-established, healthy, matched plants selected for this experiment, five served as controls and five were given GA in water solution. The solution containing 100 micrograms per milliliter was dropped into the spindle behind the top dewlap. Feedings in micrograms were as follows: July 11, 10; July 15, 10; August 3, 40; August 8, 20.

The treated plants increased in length 50 per cent faster than the untreated.

Figure 11 shows four of the paired plants on August 31. The treated ones on the left are much taller and have more exposed mature joints.

The striking effects of minute amounts of this

Figure 11. While receiving a total of 80 micrograms of gibberellic acid, the treated plants on the left elongated 50 per cent faster than their controls on the right.



* We are indebted to Dr. F. H. Stodola, USDA, and to Dr. J. D. Garber, Merck, Sharpe & Dohme, for generous samples of gibberellic acid which made this work possible.

EFFECT OF VARYING AMOUNTS OF ADDITIONAL NUTRIENTS ON CANE AND POL YIELDS.

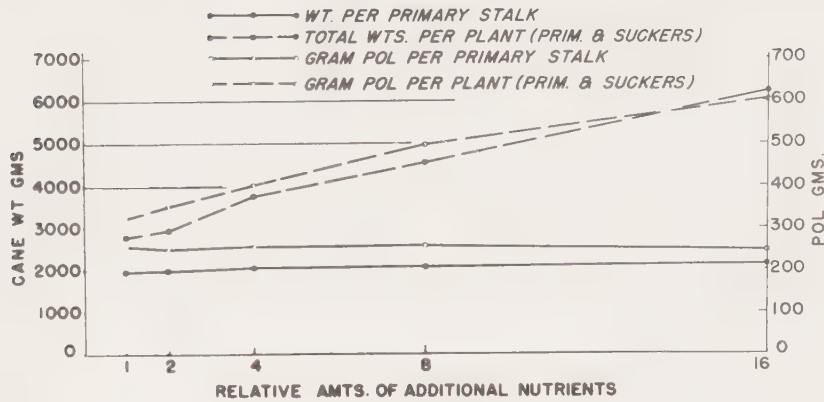


Figure 12.

wonder chemical suggest the possibility that it may find a use in the sugarcane industry. With other species, it has been known to change bunch beans into pole beans, make some dwarf corn

grow as rapidly as normal corn, replace vernalization in the flower induction process, etc. It is now being tested in all phases of cane growing from germination to flowering and ripening.

SUCKERS SUFFER FROM RESTRICTED NUTRIENTS

As the nutritive level of culture solutions is lowered, the chief effect is seen in decreased numbers of suckers. Figure 12 shows that with 16-fold range of nutrient concentration, the total weight

and sucrose content of the primary stalks are almost unchanged. However, the total yield per pot in both weight and sugar increased almost linearly to double that of the most restricted feeding.

COORDINATED TESTS INDICATE DESIRED NUTRIENT LEVELS FOR OPTIMUM GROWTH

Analysis of the data from Group Test #11 (American Factors, Ltd.) has moved along well, and many relationships between fertilizer applied, tissue analysis, and yield have been clarified. Internal conditions associated with maximum yields are more clearly defined. Table 1 shows how cer-

tain analytical values are related. Yield response is falling rapidly with increased fertilizer and it can be expected that plants averaging the values resulting from 300 pounds of nitrogen per acre during the six to 12 months' period should approach maximum yields.

TABLE 1

Analytical Values* Associated with Level of Nitrogen,
Spring and Fall Plant Combined, Six Amfac Plantations

	Leaf TN	8-10 TN	Sheath Mois- ture	8-10 Mois- ture	8-10 Reducing Sugars	8-10 Sucrose	Yield Gain on Lower Level
	%	%	%	%	%	RS	%
0# N/A.....	1.54	0.134	79.48	81.1	10.3	3.3	.....
150# N/A.....	1.79	0.217	80.92	83.2	17.2	1.6	54.0
300# N/A.....	1.92	0.289	81.52	84.1	20.6	1.2	10.2

* All figures are averages of 4 samples taken at 6, 8, 10 and 12 months of age.

TABLE 2

Relation of Tissue P to that Fed in Culture Solution

Test	Series	ppm P in Nutrient Solution	Age at Harvest	Total P as % Dry Weight	
				8-10 Internodes	Basal Internodes
3rd	Control P	36.6	8 mos. 3 wks.	.203	.271
	3/16 P	6.6	"	.114	.109
	1/16 P	2.8	"	.032	.020

CULTURE SOLUTIONS PEG CRITICAL LEVEL OF PHOSPHORUS

Recent studies with culture solutions support the belief that 0.031 per cent total P in the 8-10 joints is sufficient to maintain full growth of the primary stalk and prevent visible symptoms of P

deficiency. Table 2 brings out the fact that concentration in the basal joints falls faster than in the 8-10. A great inequality between the two parts of the plant indicates extreme shortage of supply.

TABLE 3

Interstalk Transport of P32 Fed to Blade No. 6

Direction of Translocation	Total Counts	Per Cent of Translocation
Up into blades, sheaths, and joints 1-5.....	499,608	40
Down into blades, sheaths, and joints 7-30.....	341,856	28
Down into other stalks of stool.....	390,224	32

P32 TRACKS PHOSPHORUS
THROUGH THE PLANT

Twelve days after tagged phosphate was applied to the 6th leaf of one stalk, 22 per cent had left the fed leaf and 6th joint. The distribution of the translocated P32 is shown in Table 3. Although much of it did go up into the young tops, the greater part moved downward and 32 per cent of it went into other stalks of the stool. This has been disputed by some workers using the less sensitive standard analytical methods. Phosphorus enters the general circulation just as well as nitrogen and carbon.

COLOR AND LEAF-PUNCH NITROGEN
HIGHLY CORRELATED

Figure 13 shows how both color (chlorophyll) and leaf-punch nitrogen respond to four levels of nitrogen at Makiki. However, the relationship between leaf-punch nitrogen and chlorophyll changes markedly with age and season. At eight months of age in February, the cool weather has reduced color to about 50 per cent of the December value without any change in nitrogen.

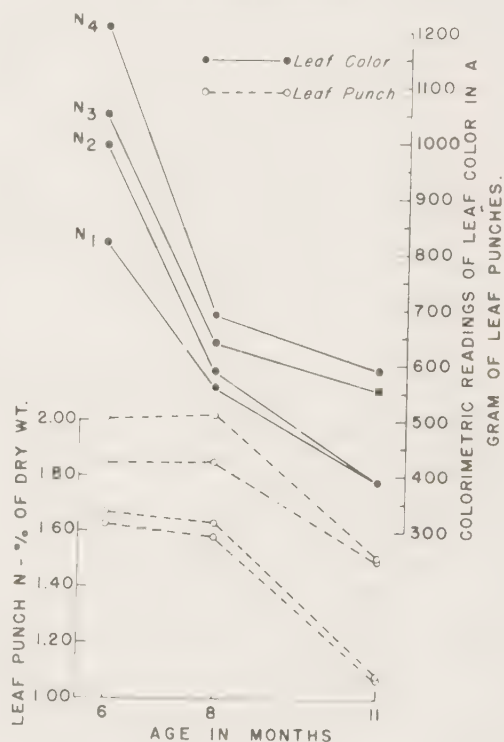
EFFECT OF N AND AGE ON LEAF COLOR
AND LEAF PUNCH N.

Figure 13.

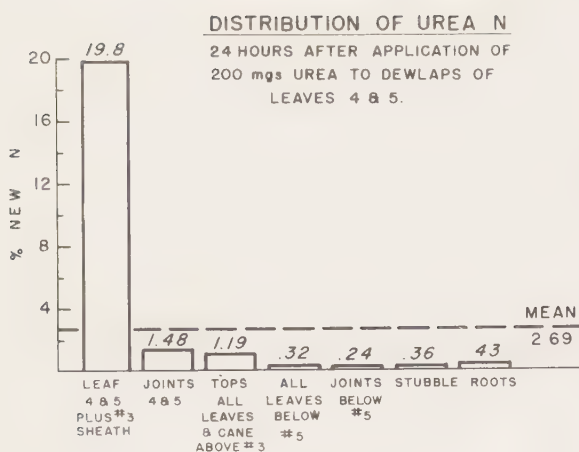


Figure 14.

HEAVY NITROGEN TRACER FOLLOWS UREA THROUGH THE PLANT

Urea (200 mg) tagged with heavy nitrogen (N^{15}) was applied behind the dewlaps of the 4th and 5th leaves on each of three plants. Complete harvests were done one, three and seven days later. The plants remained in normal culture solution during the experiment.

Absorption into the plant was rapid, being 45 per cent in 24 hours and 75 per cent in 72 hours. This effectively raised the total N in the plant, with tagged nitrogen reaching a maximum of 5.27 per cent of the plant's total N on the third day.

Figures 14, 15 and 16 show that the first rapid upward movement into the blades of the fed sheaths so enriched the lamina that on the third day, 55 per cent of the total N was tagged nitrogen. Redistribution continued into all parts, with

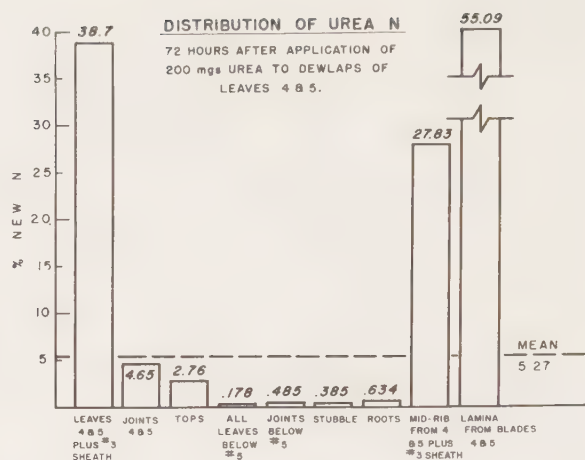


Figure 15.

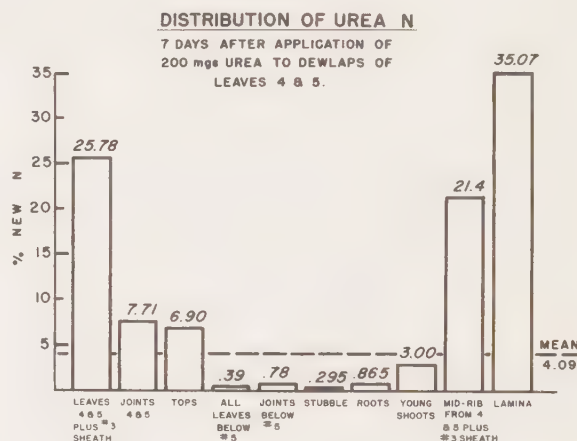


Figure 16.

the tops above the fed joints becoming highly enriched. This again emphasizes the active circulatory system of the cane plant and the dynamic equilibria existing.

UNLOCKING THE SECRETS OF MAKING SUGAR

Double tagging of products of photosynthesis with C^{14} and P^{32} have made it clear that phosphoglyceric acid (PGA), although present in the cane plant, is not an early product of its photosynthesis. Instead, the major portion of CO_2 fixed in the first few records of photosynthesis is found in phosphomalic acid and aspartic acid.

Sugar cane is quickly solarized by the combination of high light intensity and high CO_2 concentration. Figure 17 shows the depressions of photosynthetic rate at light intensities above 450 foot-candles when the CO_2 concentration is higher than 0.133 per cent.

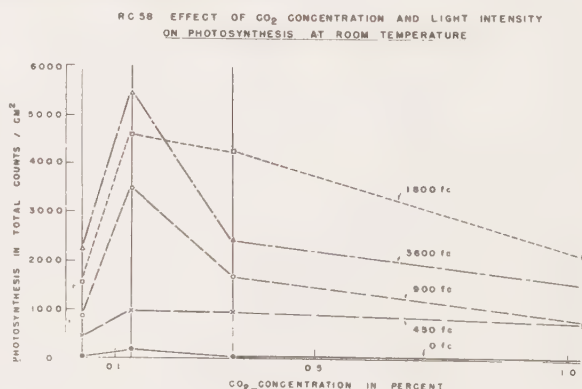


Figure 17.

EFFECT OF ADDITIONAL 100 POUNDS N PER ACRE ON MOISTURE CONTENTS OF CANE LEAF TISSUES

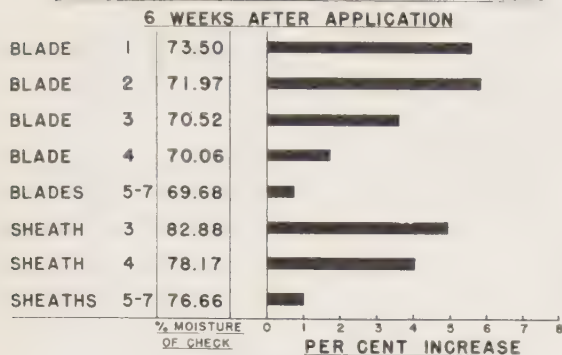


Figure 18.

EFFECT OF ADDITIONAL 100 POUNDS N PER ACRE ON MOISTURE CONTENT OF CANE TISSUES

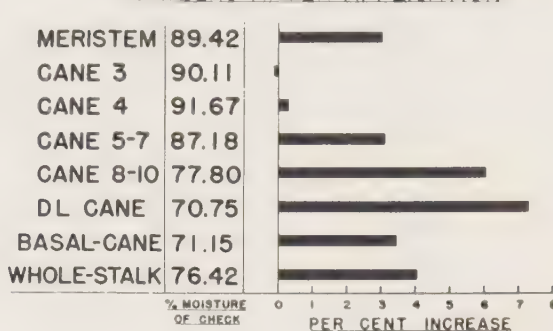


Figure 19.

LOOKING IN ON NITROGEN-MOISTURE RELATIONSHIPS

The effects of nitrogen on the moisture content of young cane plants are illustrated by Figures 18 and 19. Since the whole range of moisture levels for good growth is limited to a few per cent, the results emphasize the importance of careful selection of tissue for moisture studies.

In general, the increased moisture associated

with higher nitrogen is more easily removed by drying off as shown in Figures 20 and 21. This higher sensitivity of the high nitrogen tissues may be associated with the increased effect of nitrogen on flowering when accompanied by drying off. (For a further discussion of flowering, see page 49.)

EFFECT OF DRYING OFF FOR 47 DAYS ON MOISTURE CONTENT OF CANE LEAF TISSUES

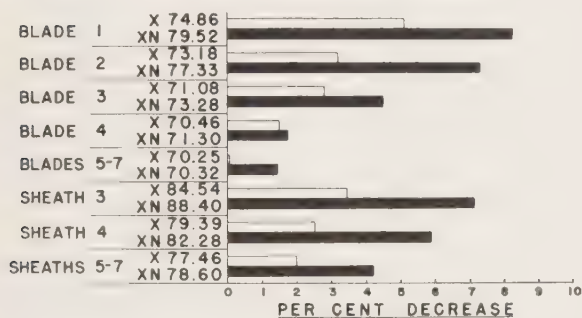


Figure 20.

EFFECT OF DRYING OFF FOR 47 DAYS ON MOISTURE CONTENT OF CANE TISSUES

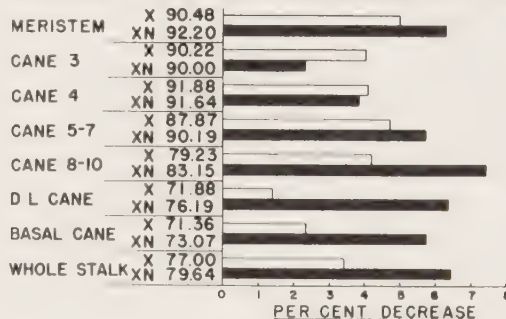


Figure 21.

MOISTURE TENSION IMPORTANT IN PHOTOSYNTHESIS AND GROWTH

The effects of moisture tension on germination, photosynthesis and growth are illustrated in Figures 22 and 23. On page 14 of the 1955 Annual Report, the reduction of photosynthesis by soil moisture tension was shown in five cycles of drying and irrigation. Photosynthetic rate fell gradually as moisture tension increased until at permanent wilting point it was about 20 per cent of the maximum rate. These experiments were repeated in culture solution by adding NaCl or

sucrose to increase osmotic pressure around the roots. Salt and sugar exert similar effects. Photosynthesis was measured on the infrared spectrophotometer.

Figure 22 summarizes the data. Dewlap growth ceases first; then spindle growth. Meanwhile, photosynthesis continues at a reduced rate with no sharp break evident. Figure 23 shows the effect of sucrose osmotic pressure on germination. Results with NaCl were essentially the same.

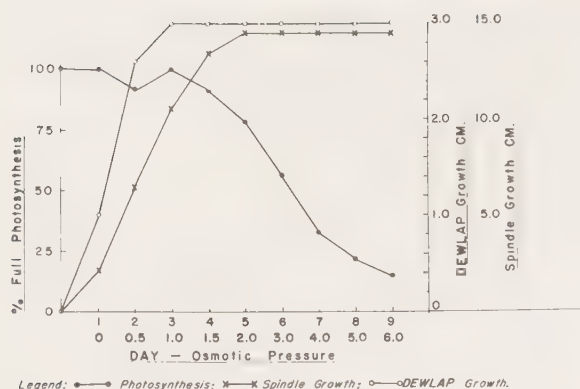


Figure 22.

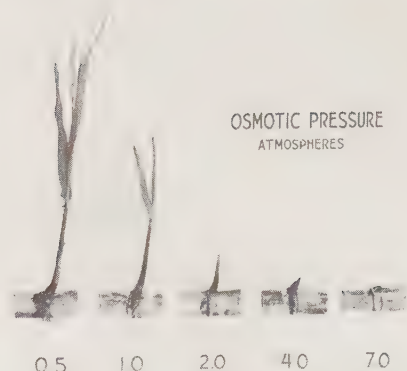


Figure 23.

DRYING OFF INCREASES SUCROSE TO FIBER RATIO

Ripening effects of drying off are summarized in Figure 24. Sucrose to fiber ratios were used as a base independent of change in concentration due to evaporation alone. The striking increase in ratio of sucrose to fiber during three

months of drying may come about by continued photosynthesis after growth has ceased, as illustrated in Figure 22. Some of it comes also by conversion to sucrose of reducing sugars which decrease markedly with drying.

STUDY OF MOISTURE TENSION CHARACTERISTICS OF PRINCIPAL SOIL SERIES CONTINUING

Hundreds of moisture sorption curves have characterized the N1, N2, N3 and N5 families of the low humic latosols.

Work is in progress on the T3 and T4 soils of the humic ferruginous latosols, the H2 and H3 of

the gray hydromorphic soils and the N4 family of the low humic latosols. These moisture tension curves are serving as the basis for intelligent irrigation management regardless of methods of irrigation control.

IMPROVEMENTS MADE IN BOUYOUCOS BLOCKS

Experience with several thousand blocks equipped with the twisted wire type of electrode shows them to be superior to the "dipped" block electrodes formerly used. Calibration values are more stable and reports indicate that the block sensitivity is higher than any formerly experienced.

Several thousand more acres of sugar cane went under irrigation control with the Bouyoucos blocks in 1956. They still offer the best method of irrigation control developed to date.

SUCROSE : FIBER RATIOS IN DRYING-OFF EXPERIMENT

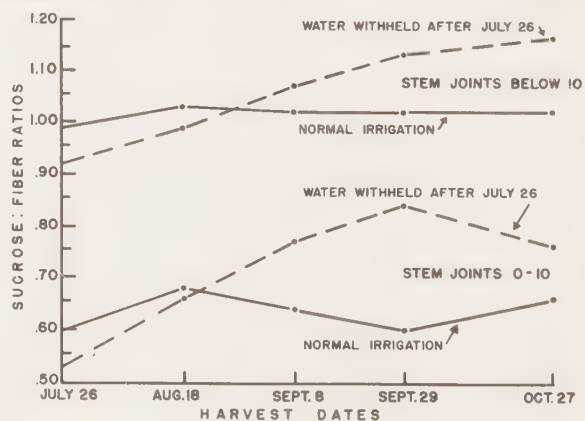


Figure 24.

EXPERIMENT STATION



Figure 25. Installation at Poamoho Substation for determining flow transitions from supply ditches to flume lines.

IMPROVEMENTS MADE IN FURROW IRRIGATION

Furrow water-flow studies have been conducted on several plantations during the past year. These studies have both long and short term objectives. The long term objective is to provide information upon which to base changes in length and slope of furrows. The short term objective is to determine how to obtain the best possible irrigation with the present layout. The results from the water-flow tests are expressed in terms of volume of water flow and elapsed time for an irrigation, which will apply an adequate amount of water and will also give a good water distribution. The flumes used in these studies are availa-

ble locally and are individually calibrated. The Station has developed facilities for calibrating small flumes to insure useful performance in the field. Special forms have been developed to simplify the analysis of the field data.

Water-flow studies have continued to show the importance of rate adjustments when compared to changes in slope of line. The time for water to flow to the end of 200-foot furrows is increased approximately fivefold in 19-month-old cane as compared to three-month-old cane. This increase is due mainly to the resistance to water flow of the lodged cane and trash in the lines.

PROGRESS MADE IN IRRIGATION FLUMES AND OUTLETS STUDIES

The cooperative test work which has been done on metal flumes and outlets by the Agronomy and Field Engineering Departments was duplicated for concrete flumes. Representative sizes were selected, and flume capacities, factors affecting capacity, and outlet discharges were tested.

There has been some doubt as to the capacities of the tubes used to get water from level ditches to furrows. Representative sizes were tested and calibrated.

A 400-foot line was installed at Waipio Substation to demonstrate a recommended metal flume cross section and to test the molded outlet. The flume cross section is a half circle with flat bottom and with the edges rolled in.

The development of the molded outlet has progressed far enough so that a few can be made available to plantations for testing. However, the cost of the present design is about two times the maximum figure indicated by plantation men as

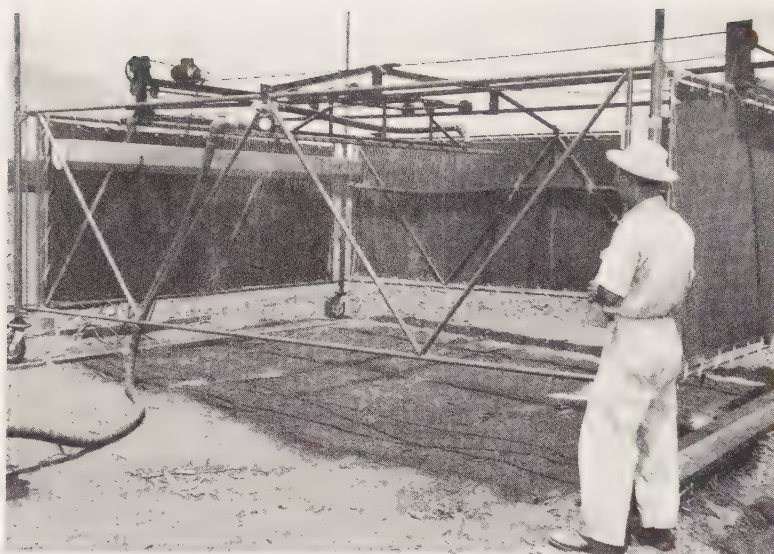


Figure 26. The infiltrometer, used to determine rates of water application in an overhead system of irrigation, consists of a light metal framework which can be moved over small plots. Water can be discharged at selected intensities and intervals.

acceptable. A sample of a more economical design is being supplied by Stauffer Chemical Company for testing.

A test installation for determining flow transitions from supply ditches to flume lines was made at the Hawaii Agricultural Experiment Station on a Waialua supply ditch (Figure 25). The first

eight of 28 outlined tests have been completed. The completed tests cover the flow transition from earth-lined supply ditches into metal flumes. The tests yet to be completed cover transitions from earth-lined supply ditches into concrete flumes, and transition from concrete-lined supply ditches into metal and concrete flumes.

PROGRESS MADE IN OVERHEAD IRRIGATION STUDIES

A new type of sprinkler infiltrometer has been constructed to study water infiltration properties of soil. It is planned to use the results from these water intake studies to aid in the selection and design of overhead irrigation systems for specific soils. These studies also provide a basis for determining whether shallow furrow or flat culture can be used in overhead irrigation layouts.

The infiltrometer is designed to control the water-drop impact energy and hence make it possi-

ble to study its effects on soil. Water is discharged at known drop sizes, velocity and intensity. Drop sizes are varied by changing orifice diameters. Velocity is adjusted by varying the discharge pressure at each orifice. Intensity is adjusted by the cycling frequency, ground speed of orifice plate, and/or number of holes in the orifice plates (Figure 26).

Early phases of the testing program are being carried out in cooperation with HC & S on Maui.

SOIL EROSION REDUCED BY DIVERSION DITCHES ON HAWAII

Erosion losses (see cover) have been a serious threat to the sugar industry since its origin. With each heavy rain, unprotected fields are being churned into countless rivers of mud carrying fertile topsoil to the sea. As water moves over

the soil surface, it accumulates in channels and moves faster and faster. As water doubles in velocity, its carrying capacity of soil in suspension increases to the 7th power.

Kaiwiki was the first plantation to install diver-



Figure 27. Looking upstream in diversion ditch on a two per cent grade in Field 26, Hutchinson Sugar Company, Ltd. Note contour planting of cane to retard surface runoff.

sion ditches in an attempt to reduce the speed and volume of runoff. These diversion ditches, even though small and approximately on a four per cent slope, have been reasonably effective in minimizing losses of valuable surface soil.

The Soil Conservation Service in recent years has been cooperating with the plantations in an effort to reduce erosion losses. They have been assisting in the construction of diversion ditches illustrated in Figure 27.

SOIL IMPROVEMENT PROGRAMS EXPANDING

Several thousands of acres of sugarcane soils whose productive capacity was limited by poor physical conditions have been given the "Organic Matter Treatment" over the past few years. Soil improvement with excess bagasse and cane trash from the cleaning plants is being practiced on an ever-increasing acreage.

Grade A experiments prior to 1956 have shown response varying from one to 2.7 tons sugar per acre. Recent tests have continued to show promise. The yield decline test at Oahu Sugar showed a gain of 1.3 TPA for additions of 32 tons of trash per acre for 37-1933. Applications of 60 tons bagasse per acre at HC&S resulted in an impressive 2.8 TSA gain over the checks.

The largest acreages of soils improved in recent years by addition of organic matter are at Kekaha Sugar Company, Ltd., Ewa, and Pioneer Mill Company, Ltd. Smaller acreages that have received the trash treatment are at Olokele Sugar Company,

Ltd., Grove Farm Company, Ltd., Lihue, Kilauea Sugar Company, Ltd., Kahuku Plantation Company, Oahu Sugar, Waialua, Wailuku Sugar Company, HC&S, and Hilo Sugar Company, Ltd.

A relatively recent development that is increasing interest in soil improvement is the effective trash-chopping plant developed by Pioneer Mill. Figure 28 shows the chopped trash from the cleaning plant at the mill, and Figure 29 shows the chopped trash being spread on areas which are to be plowed and planted. Pioneer Mill has proved it is feasible to haul the green chopped trash directly to the fields being plowed. This eliminates double handling and will make it possible to treat those sections of fields whose soils will show the greatest improvement, without postponing plowing operations too long. If it is desirable to treat entire fields, additional transport units will have to haul stockpiled trash and bagasse to the field being harvested.



Figure 28. Pioneer Mill Company's trash chopping unit at their cleaning plant.



Figure 29. The green chopped cane trash is spread prior to plowing.

RAT DAMAGE JEOPARDIZES VALIDITY OF YIELD DATA

High sucrose and low fiber are desirable attributes from the standpoint of maximizing factory capacity. However, varieties possessing these attributes are attractive to rats. In small plot variety trials, rats feed selectively, seeking out those varieties which are high in sucrose and low in fiber.

The object of variety trials is to estimate the relative capacities of the competitors to produce sugar if planted on a field scale. Unfortunately,

harvesting results from variety tests which have suffered rat damage are likely to reflect relative attractiveness to rats rather than inherent yielding ability.

The adoption of an industry-wide routine of rigorous rat control in variety tests is imperative if misleading results are to be kept at a minimum. Permanent feeding stations will provide good protection if properly placed and regularly serviced.

POISONED PELLETS AND TORPEDOES ATTACK INCREASING RAT PROBLEM

The basic and reliable feeding-station method of rat control continues to be effective wherever adequate attention is given to the rat problem. Where rat populations have built up, emergency measures have been studied in an effort to reduce the population to low levels.

Considerable effort has been expended in developing poisoned pellets for air distribution. Essentially, they consist of a cereal mixture, the poison, a mold preventive, a paraffin coating as a moisture deterrent, a vegetable oil attractant for the rats, and an insect repellent (Figure 30).

TABLE 4

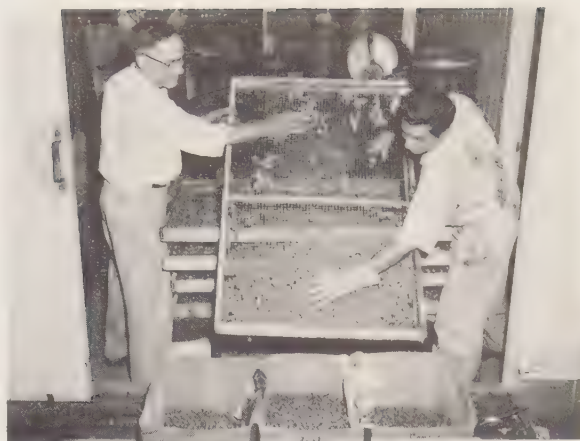
Theoretical Efficiency of a Single Thallium Sulfate Pellet
Expressed in Weight of Rats Killed

		Length of Pellets			
		1/4"	1/2"	3/4"	1"
Average weight of rat } pellets in grams }	Not waxed	0.75*	1.5	2.35	3.0
	Waxed	1.2*	2.1	2.85	3.45
Weights of rats that should } be killed by each pellet** }	Pounds	.34	.68	1.06	1.3
	Grams	154.2	308.45	480.5	589.7

* Estimate.

** Calculated on pellet weight before waxing.

Figure 30. Poisoned pellets are quickly lifted from the paraffin dip and thrown on screened trays to cool and harden the coating. When cool, the pellets are poured into boxes or drums and stored. Before being distributed in the field, the pellets are sprayed with raw linseed oil to make them attractive to the rats.



The toxicity of these pellets is shown in Table 4. One three-quarter-inch pellet is a minimum lethal dose for one pound of rat. There are approximately 160 three-quarter-inch pellets per pound.

Cage tests conducted at Makiki show that not over 86 per cent of the rats that actually find a pellet before it spoils in the field would be killed. Judging from past experience with direct poisoning of rats, this percentage of acceptance is about all that can be expected.

Several observation tests were conducted in and along the borders of Hilo Sugar fields. The bait remained palatable to the rats for at least three nights, even in relatively wet areas. Heavy acceptance of the bait occurred during the first night, and was highly satisfactory even when one-fourth to three-fourths of an inch of rain fell. The presence of up to five per cent lindane, chlordane or benzene hexachloride in the linseed oil attractant did not seriously interfere with acceptance of pellets by rats.

Pellets can easily be applied by airplane. It is estimated that about five pounds of pellets (780-800) should be applied per acre. This amount, or more, might be needed for a strip of waste land or a gulch adjacent to cane. By skipping swaths of the airplane across the inside of fields,

the average application per acre can be cut to any desired amount.

By adjusting the gate opening on the hopper of the plane and making a pass or two along a road or airstrip, the quantity of pellets and the distribution pattern can be determined and specifications made. This new approach to the rat problem offers plantations an additional tool which can be made practical and economical. However, all direct poisoning by pellets or torpedoes has distinct limitations. To repeat the use of direct poisoning in a given area too soon, drastically reduces the acceptance percentage and hastens the development of a rat population made up of bait-shy survivors.

Studies were continued with the airplane distribution of Lihue double torpedoes. The trials indicated that it is feasible to distribute double torpedoes to suit the needs of a particular location and situation. As a basis for further study, it is recommended that specifications start with a slot opening of two and one-half inches in the bottom of the hopper and that the plane fly at 40 feet elevation at a speed of 90 miles per hour. This should distribute less than 15 pounds of torpedoes (65 per pound) per acre over a swath of about 75 feet. The application rate should be reduced for all but the most critical situations.

PIVAL EQUAL TO WARFARIN AS RAT BAIT

Data on preference tests in cages conducted in 1952-1953 indicated that when Norway rats had a free choice of rolled oats containing Pival in one pan and Warfarin in another pan, they

preferred Pival to Warfarin oats by a factor of three to one. This indicated some taste factor favoring the Pival bait, as both baits were equally effective in causing death.

Other cage studies showed that the average amount of Pival bait consumed in per cent of body weight before dying, for white Norway rats, was 20.3 per cent. This is about identical with the 20.4 per cent figure obtained under the same conditions for Warfarin. Likewise, the number of days from the first meal until death was 5.4 for both poisons. Thus Pival was found to be as efficient as Warfarin in killing Norway rats.

A bait preference test comparing Pival with Warfarin was conducted at Kilauea. The two baits were tested in paired stations in pans immediately adjacent. On the basis of total bait consumed for

the entire test period, Warfarin was favored over Pival by 11.6 per cent. Warfarin was preferred over Pival in 82 stations to 46.

From these studies it is concluded that: (1) neither poison is outstandingly superior; (2) a preference for Warfarin seems indicated, but does not warrant its selection exclusively; (3) the indicated preference of rats for Pival over Warfarin in cage tests was not demonstrated in this field test; (4) the major consideration in the selection of an anti-coagulant poison for field use should remain the prices and availability of the competing products.

FUMARIN EQUAL TO WARFARIN AS RAT BAIT

Recent cage tests at Makiki indicate Fumarin to be equal to Warfarin in most essential characteristics, and possibly superior in one. This is brought out in the study of the susceptibility and resistance of the different species. The Norway appears to be the most susceptible while the Alexandrinus and Black Rattus are the most resistant

to this poison. This is also true for Warfarin. Fumarin appears to be more toxic to Hawaiiensis than to either Alexandrinus or Black Rattus. This is not true for Warfarin.

It is essential that a more effective anti-coagulant than Warfarin be developed for the Hawaiiensis species.

COLORING OF RAT BAITS STUDIED

Birds have become a nuisance in certain plantation fields because they have acquired the bad habit of stealing grain from the rat feeding stations. Birds are very tolerant of Warfarin bait; consequently most of them continue to consume appreciable quantities. Hiding the stations more completely in the cane is only a partial solution of the problem.

Recently, in cooperation with Grove Farm and Hawaii Chemical Company, two colored bait tests were installed. The colors used were methylene

blue and malachite green. The results of these tests indicate that for the first week birds were shy about eating colored oats when uncolored oats were available in adjacent pans. Later, the birds gradually overcame their fear of the colored oats and began to eat from all pans without preference, particularly if the pans were out in the open. However, one test at the Kauai Variety Station indicated a definite preference for the non-colored over the colored oats during the full 21 days of the test.

DISEASES

VARIETAL RESISTANCE TRIALS IN FIJI PRODUCE INTERESTING RESULTS

The results from the 1956 downy mildew trials at Lautoka, Fiji, in the cooperative project with the Colonial Sugar Refining Co., Ltd., for testing Hawaiian canes against downy mildew and Fiji disease, were very satisfactory, thus making it possible to establish the reaction of all varieties to the disease (Figure 31).

The susceptibility of each of the 33 Hawaiian varieties and of the other seven varieties tested, was graded as shown.

As the result of the extremely low leafhopper population, the degree of Fiji disease transmission was insufficient to evaluate the reaction of the varieties to this disease (Figure 32). A survey of commercial plantings at Lautoka showed that a much higher leafhopper population was supported by the varieties Galba, Ajax and Badila than by Pindar and Ragnar. Test plantings of the former varieties will be made in the present Fiji disease testing area as well as in other locations in an attempt to increase the hopper population. The 71 varieties in the present trials will

be retested in the 1957 trials, along with the 25 varieties now under quarantine at Yaqara.

Index or standard varieties of known susceptibility or resistance to each disease will be included in the 1957 downy mildew and Fiji disease trials.

Susceptibility to Downy Mildew

32-8560	+	50-5386	—
41-5428	=	6828	++
44- 640	—	6877	++
45-2608	=+	6976	++
46- 919	=	7209	—
48-3166	—	7258	—
4178	=	51- 179	—
4646	=—	703	++
49- 118	=	1016	—
722	=+	4187	=+
2040	=—	4332	—
2108	++	52- 123	—
3666	=	876	—
4259	+	Co. 270	=+
4267	—	Ragnar	+
50- 529	++	Pindar	=+
723	++	Eros	—
848	=	Lunar	++
3861	—	Q 50	=+
5114	+	49R4418	—

Figure 31. Cane stalks affected with downy mildew are greatly depressed in growth. Note small stalk size in an affected stool of 50-3861 in contrast to that in a healthy stool.





Figure 32. Young ratoons of 38-2915 affected with Fiji disease. Note severe stunting in foreground in contrast with healthy cane in background.

MORE SAFEGUARDS AT MOLOKAI QUARANTINE

All cuttings of imported varieties are given the long hot-water treatment (LHWT 50°C. for 2 hours) prior to their release from Molokai, consequently guarding against the introduction of symptomless diseases and new strains of ratoon stunting disease. Internal symptoms of ratoon stunting disease have been found on a few imported varieties.

In cooperation with members of the Quarantine Committee, 18 new varieties were received from the United States Department of Agriculture and were planted in the quarantine house on November 9, 1955. The 21 varieties imported through the USDA in 1954, having completed their two-year quarantine period, were released to the other islands.

THE LOCAL DISEASE PICTURE FOR 1956

Leaf Freckle. Leaf freckle was less severe than in former years. As previously reported, the severity of leaf freckle has been shown to be associated with subnormal soil fertility during periods of low temperatures.

Leaf Scald. Leaf scald appeared only as scattered cases on Hawaii; no outbreaks of the disease occurred on 44-3098, as in 1954. The low incidence of leaf scald is correlated with favorable growing conditions.

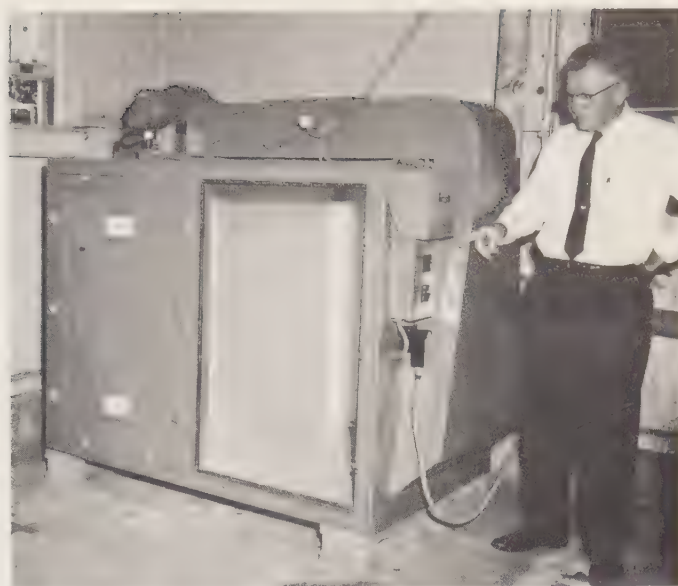
Ratoon Stunting. Ratoon stunting disease (RSD) was not found to be widespread; the majority of plantations have established disease-free areas which have been developed from seed given the long hot-water treatment. Such areas may be drawn upon later, should the disease become a serious field problem.

A portable hot-air unit (Figure 33) was constructed for treating cuttings against RSD. The air is circulated over heating elements and enters the closed unit through three inlets with adjustable baffles; the temperature is automatically controlled with a mercury thermoregulator.

The hot-air treatment of sugarcane cuttings for controlling ratoon stunting disease is eight hours at 54°C. This treatment is less harmful to germination than the LHWT. With the HAT there is a 15 to 20 per cent moisture loss from the cuttings and a slight drying of the bud tissues. The LHWT has a tendency to soften the buds and make them more susceptible to mechanical damage and invasion by secondary organisms.

Cane growth from cuttings of 38-2915 affected with chlorotic streak disease and inoculated with

Figure 33. An electrically heated, portable hot air unit for treating cuttings affected with ratoon stunting disease. The HAT for controlling RSD is eight hours at 54° C.



ratoon stunting disease before planting was severely retarded in comparison with growth from cuttings affected with CSD only and from healthy plants (Figure 34). The marked reduction in growth from both diseases has not been observed in cuttings affected with only one disease. Severe losses may be expected where cane is affected with CSD and later contracts RSD, or vice versa.

The field control of RSD, determined by studies in Hawaii and elsewhere, is accomplished as follows: (1) the development by the use of the LHWT or HAT of disease-free areas as seed sources, (2) the selection of healthy cuttings for planting material, and (3) knife sterilization to prevent transmission.

The majority of the 61 sugarcane varieties and species, inoculated with RSD and planted in a varietal resistance test at Waipio, showed a high percentage of stalks with internal symptoms of RSD. The varieties with the lowest percentage of symptoms were: 39-7028 (3%), 51-1016 (10%), 48-4646 (11%), *Ramu S. robustum* (11%), 48-3649 (13%), 48-2094 (14%), and *Burma S. spontaneum* (14%).

Inoculum from stalks of 39-7028 and 48-4646, previously inoculated but without RSD symptoms, was used to inoculate healthy cuttings of 45-2120, which shows very prominent red bundles at the nodes when affected with RSD. The presence in 45-2120 of only a low percentage of RSD from

these inoculations indicates that 39-7028 and 48-4646 are resistant to the disease.

Fifty commercial and promising varieties, with and without RSD, were spread at Waipio Substation to test further their reaction to RSD and to provide planting material for yield tests.

Of the chemicals used in 1955 and 1956 to swab knives to prevent knife transmission of RSD, good control was obtained from the following: Clorox; Lysol, 5 per cent and above; Bionol, 5 per cent; isopropyl alcohol, 50 per cent; Wesco-dyne, 5 per cent; and phenyl mercuric acetate (PMA), 5 per cent. Because of the corrosive effects of Clorox on knives, Lysol or one of the other chemicals listed may be used.

To determine how long the infective principle of RSD remains capable of causing infection after a knife has been contaminated with juice of diseased cane, contaminated knives were used to cut healthy stalks of 45-2120 immediately and at intervals of 2, 6, 24, and 48 hours. The percentages of RSD transmission when stalks were cut immediately and after two and six hours following knife contamination, were 81.3, 8.3, and 4.6, respectively. RSD was not transmitted by contaminated knives after 24 hours.

Chlorotic Streak. Chlorotic streak disease is still of major importance on varieties growing in low-lying and poorly-drained areas.

It has been reported that cane plants may con-



Figure 34. Growth of 38-2915 affected with CSD and RSD (center) is much more depressed than when it is affected with CSD alone (right). Healthy cane is shown on the left.

tract CSD from the soil. In water culture studies, CSD symptoms did not develop on leaves of healthy plants grown in the same cultures in which plants with CSD had previously grown.

Where six healthy cuttings of 38-2915, and six cuttings severely affected with CSD were grown separately in soil in each of six 25-gallon drums, the average number of stalks per drum from the CSD cuttings was 5.5 as compared to 13 from the healthy cuttings. This substantiates earlier observations that cuttings severely affected with CSD not only germinate less readily than healthy cuttings do, but subsequently grow less well.

Red Rot. Red rot disease was less severe than in 1955; however, it presents a serious problem, especially with the variety 38-2915.

Red rot is confined to a few plantations on Kauai, and is best controlled by the use of resistant varieties. Losses from the disease may be minimized by harvesting susceptible varieties as soon as possible after the first symptoms of the disease appear. The variety 39-7028 has shown a

higher degree of resistance than 38-2915, and for this reason where red rot is a problem, 39-7028 is being grown.

A red rot test was installed at Lihue wherein the leading commercial varieties will be exposed to natural infection and later inoculated with strains of the red rot organism in order to determine their susceptibility to the disease.

Inasmuch as red rot has been found only on Kauai, it is urged that a careful watch for symptoms of the disease be maintained on the other islands, especially on 38-2915 which now occupies large areas throughout the Territory.

Miscellaneous. Pineapple disease has been controlled by the PMA treatment of cuttings prior to planting.

Under wet and cold soil conditions, rotting of cuttings caused by the invasion of secondary organisms has resulted in poor germination of 38-2915 in localized areas. The PMA treatment of cuttings prior to planting was recommended for improving germination under such conditions.

SOIL FUMIGANTS AFFECT SOIL MICROORGANISMS

Results to date of a laboratory experiment to determine the effects of DD, EDB and BBC on

soil microorganisms indicate that DD mixtures at 40 gallons per acre and EDB at eight gallons per

acre completely inhibited nitrification of the added ammonium nitrogen in the form of aqua ammonia for the first four weeks. BBC, at three gallons per acre, exhibited only a slight inhibitory action on the nitrifying bacteria.

The total numbers of bacteria, actinomycetes,

and fungi, were not appreciably affected by the different treatments after two-week incubation of the soil samples in contact with the fumigants.

The experiment is being continued for further observations in relation to the effects of the fumigants on soil microorganisms.

HOT PMA STIMULATES GERMINATION AT PAUAHAU

Germination studies with 44-3098, comparing hot PMA-treated seed with cold PMA-sprayed seed, were reported from Paaupau Sugar Company, Ltd. The test was harvested at 26.5 months. The germination at two weeks for the HPMa plots was 77 per cent, as compared to 20 per cent for the cold PMA. The HPMa plots closed in more

rapidly and the cane was one to two feet higher at closing-in time. A stalk census taken at four months showed 3.0 stalks per foot for the HPMa plots and 2.1 stalks for the cold PMA plots. At harvest, the average cane yield from three HPMa plots was 124.5 TCPA and from the cold PMA plots 104.4.

CAPTAN CONTROLS PYTHIUM IN SEEDLING FLATS

Captan (N-trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide), an organic fungicide which has been found effective against many plant pathogens, gave good control of *Pythium* root rot of cane seedlings growing in flats. The tests in-

dicated that an application of Captan as a soil drench to seedling flats at the rate of two grams per flat, at one week intervals during periods of wet weather, and at two to three week intervals when there is less rain, would give good control.

SOIL FUMIGATION INTEREST RISES

During the past two years, a large number of observation and Grade A soil fumigation tests have been installed on the various plantations. The fumigants DD, EDB, and to some extent BBC and methyl bromide, were used, chiefly as pre-plant treatments. In some instances, an excellent growth response was obtained, while in other instances, little or no response was secured.

An intensive nematode survey of all plantations was conducted and nematodes from over 3000 soil samples were extracted and identified. The six species of nematodes considered in the survey are: *Helicotylenchus*, *Radopholis*, *Paratylenchus*, *Meloidogyne*, *Pratylenchus* and *Trichodorus*. The last three are considered the most harmful to sugar cane.

The results of the plantation survey showed that: (1) the numbers and types of nematodes vary greatly between plantations and in different

fields on a single plantation; (2) the parasitic types of nematodes, now recognized elsewhere as causing crop damage, were found to be sufficiently numerous in some areas to cause reduced yields; (3) a correlation between initial high populations of nematodes and a definite response to soil fumigation has been obtained; and (4) the greatest responses to soil fumigation may be expected in those fields having the largest numbers of nematodes, and such fields are suggested for soil fumigation tests.

Dr. H. J. Carter, a physician from La Habra, California, became interested in the nematode problem while spending a vacation in Hawaii. Laboratory facilities were made available to him during the eight months of his stay, making it possible to conduct the plantation nematode survey and many other studies dealing with nematodes in relation to varietal yield decline.

FACTORY

ION EXCHANGE MEMBRANES DEMINERALIZE SUGAR SOLUTIONS

The experimental Ionics, Inc., electric membrane demineralization pilot plant was put into operation at the Puunene factory of HC&S in April. Demineralization studies have been under way continuously since that time (Figure 35).

Optimum operating conditions have been established, and it has been found that unfiltered juice and syrup can be processed without plugging the cells. A series of runs, at 15, 30, and 45 per cent demineralization, has been carried through the sugar boiling phases to final molasses in order to

determine sugar recoveries. These molasses samples are now undergoing exhaustibility tests.

The effectiveness of the process in removing dissolved salts, particularly potassium chloride, has been demonstrated. The major problem has been a buildup of electrical resistance in the anion membranes. This limits the usable life at present to around one month's operation. This problem is being studied both here and at the Ionics laboratory in Cambridge, Massachusetts. Progress on its solution has already been made.

SALTS AFFECT RATE OF CRYSTALLIZATION OF SUGAR

Salts present in cane juice have a pronounced effect upon the rate of crystallization of sugar from syrup and molasses. Laboratory studies during the year have given the quantitative nature of some of the effects.

As shown in Figures 36 and 37, potassium chloride and sodium chloride reduce the rate of crystallization, whereas magnesium chloride, cal-

cium chloride and potassium sulfate increase the rate at low concentrations.

Mixtures of potassium chloride and magnesium chloride have a much greater effect in decreasing the rate of crystallization than potassium chloride alone. This shows that the effect of salts is not additive and demonstrates the complexity of the factors in sugar crystallization in the factory.

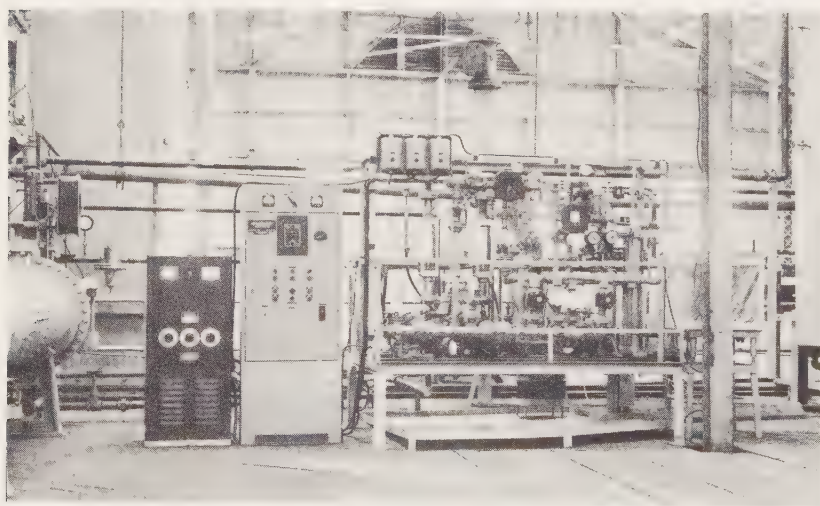


Figure 35. Electric membrane demineralization pilot plant at Puunene factory, HC&S.

Figure 36. Effect of inorganic salts on the rate of crystallization of sucrose. Original sucrose solution: 70.06 per cent sucrose, 29.94 per cent water; temperature, 30.6° C.

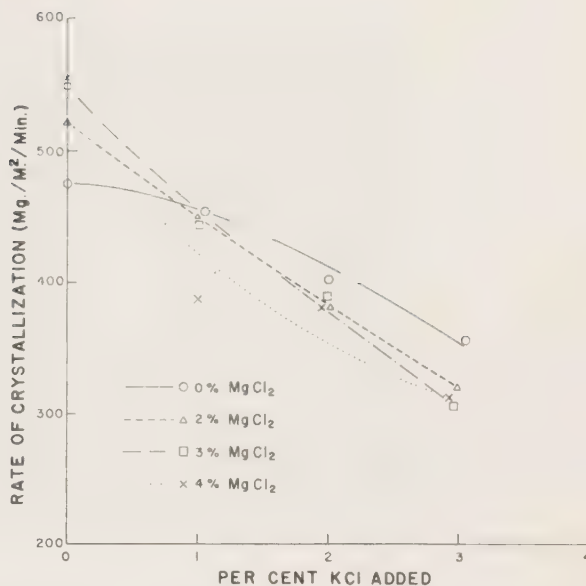
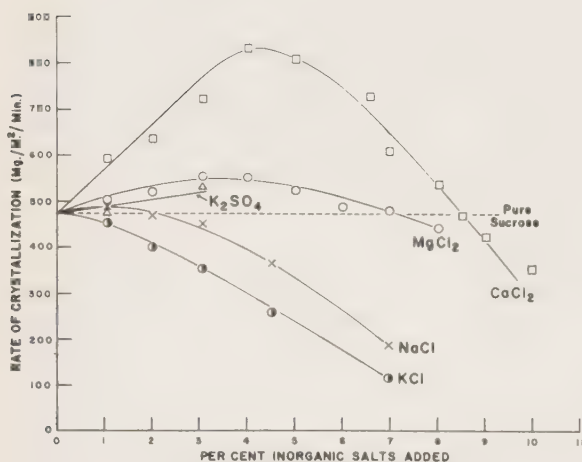


Figure 37. Effect of magnesium chloride on the rate of crystallization of sucrose in the presence of potassium chloride. Original sucrose solution: 70.06 per cent sucrose, 29.94 per cent water; temperature, 30.6° C.

POLYELECTROLYTES CLARIFY CANE JUICES

A number of new polyelectrolytes have been evaluated in the laboratory on a variety of juice types. In general, the new polyelectrolytes improve settling rate and clarity in many cases, but not as well as already available materials do.

In July, the Dow Chemical Company announced clearance of their product, Separan 2610, for use in sugar factory clarification. The cleared material is now known as ET-81. Its effect on mixed juice from the Mahaulepu section of Grove Farm, where it has been particularly useful, is shown in Figure 38. Modified ET-81, which can be produced in the raw factory from regular ET-81, is also included in the clearance. The modified material has proved to be the most generally effective flocculant available so far for sugar clarification work. It has worked in many cases where regular ET-81 has not, and generally gives better clarity and faster settling juices than the regular material.

An AC polarograph has been constructed for use in studying surface phenomena involved in clarification reactions (Figure 39). The instrument,

not available commercially, may be helpful in finding out why polyelectrolytes work in some cases and not in others, and will also be useful in studying the general fundamentals of flocculation.

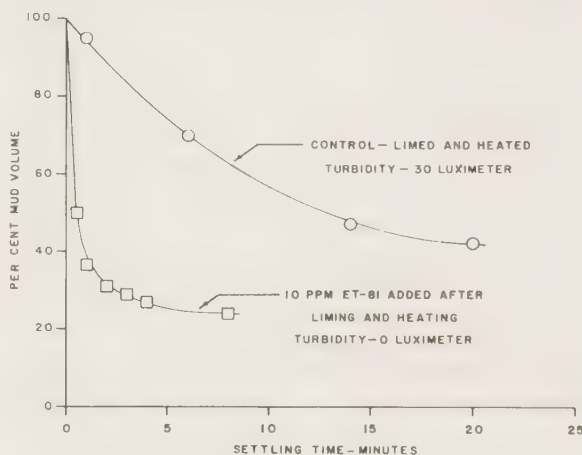


Figure 38. Effect of Dow ET-81 on settling rate of mixed juice. (Mahaulepu Section, Grove Farm Co.)

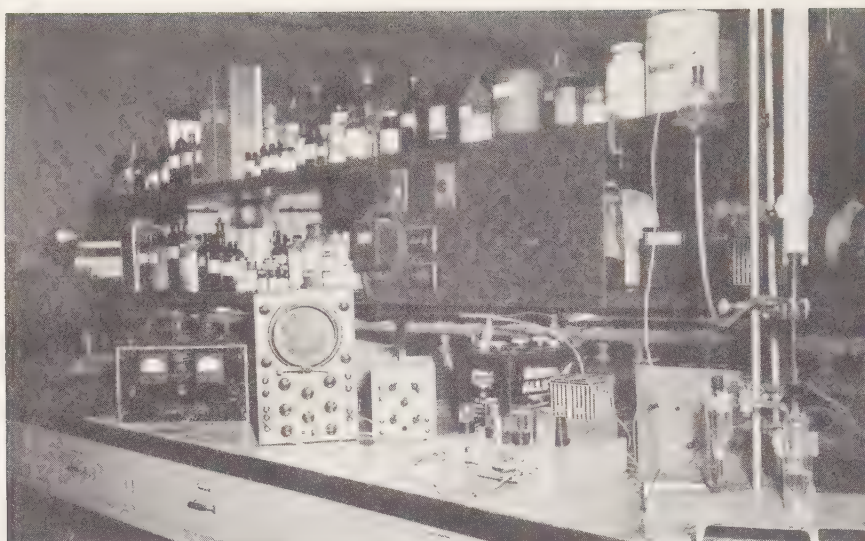


Figure 39. AC polarograph for study of surface phenomena in clarification.

RADIOACTIVE WEIGHING OF BAGASSE AT EWA TO BE RENEWED

The gamma weighing device, which was operated experimentally at the Ewa factory in 1955, was set up at the Experiment Station in 1956 for further testing and development, as considerable difficulty had been experienced in obtaining the desired one per cent accuracy of measurement.

In cooperation with the Department of Physi-

ology & Biochemistry, the bagasse stream at Ewa mill has been modified to accommodate the continuous weighing equipment using Cs137 and ion chambers.

The receiving system has been stabilized by thermostating, and it is expected that a full season of measurements will be made next year.

POLYELECTROLYTE TREATMENT ENHANCES POSSIBILITIES FOR WASHING OF CLARIFIER SETTLINGS

Success in improving juice settling rates with polyelectrolytes has revived interest in a continuous countercurrent method of washing clarifier settlings. This method had been tried on a pilot scale at the Ewa factory in 1953, and had not been successful at that time, primarily because of the slow subsidence rate of the settlings.

A laboratory-scale continuous unit was designed and constructed in 1956 to permit further study of

the process. The apparatus operates on the pulse-flow principle. Water is admitted intermittently at the bottom of the column and flows upward through the settlings. During the off periods, the settlings subside, progressing in this fashion to the mud draw-off at the bottom.

The apparatus has been modified in the light of preliminary tests, and quantitative testing is being undertaken.

NEW TYPE OF CONTINUOUS CENTRIFUGAL TRIED

An experimental model Mercone continuous conical head centrifugal was tried out at Oahu Sugar on various types of material including wash-water scum, bagasse, mixed juice, clarifier settlings, and massecuite.

The machine proved versatile in handling the wide variety of sugarhouse materials. Its greatest potential appears to be in the handling of commercial sugar massecuites, however, and tests on a commercial size machine have been arranged.

FILTRATE CLARIFICATION PROCESS INVESTIGATION COMPLETED AT WAIALUA

Tests on the experimental full-scale filtrate clarifier at Waialua factory have been completed.

The unit worked well on filtrates from mauka areas but not on filtrates from makai areas. Also, there was no detectable economic advantage in using the process even at times when it was work-

ing satisfactorily from a technical standpoint.

Contact is being maintained with the manufacturer with regard to future developments, particularly in regard to flotation treatment of mixed juice. No further work is planned, however, on the present unit.

CUTTER-WINDROWER VS. PUSHRAKE COMPARISON AT LIHUE

The 1956 series of 11 tests comparing the cutter-windrower with the pushrake at Lihue were completed. Milling and boiling house recovery figures are comparable with those obtained in the 10 tests in 1955, and show no large differences in

cane quality or yield in the two methods of harvesting.

In connection with the tests carried on this year, studies were made on losses in the A-mill cleaning plant.

POL RATIO INTEREST ON PLANTATION WIDENS

The pol ratio procedure has been in use during the year at the Island Substations. In addition, assistance has been given plantations in setting up the equipment and procedure. These include Pioneer Mill and Kekaha.

Studies of relative cane quality were made at Hakalau Sugar Company, Ltd., using this procedure. Some progress has been made on the applicability of pol ratio methods to cane quality and factory control.

STUDIES ON REFINING QUALITY OF SUGAR STARTED

A program for investigating all phases of the refining characteristics of Hawaiian sugars has been started. The program has two parts. One will be conducted by the technical staff of the California and Hawaiian Sugar Refining Corporation at Crockett, California. It will involve development of methods for analyzing and evaluating the refining quality of sugars as well as pinpointing the

costs in refining sugars according to their quality.

The other part will be conducted at the Experiment Station and will consist initially of a fundamental laboratory study of color in the sugar crystal, and an investigation in the factory of procedures designed to improve refining characteristics. Later, other factors such as filterability and crystal size will be studied.

INSECTS

LOCAL INSECTS COMPARATIVELY QUIET

No new sugarcane insects have appeared in the Territory during the year, and those already here have remained at a generally innocuous level of population.

Only two plantation calls due to unusual conditions were received, both from Kauai. They referred, respectively, to the sugarcane aphid and to *Agrotis ypsilon*, the greasy cutworm. The aphid infestation, although somewhat more protracted and extensive than is usual, was essentially repetition of a phenomenon which occurs somewhere in sugarcane fields every year. The infestation by *Agrotis*, on the other hand, was unique in that this particular cutworm had never before appeared in large numbers and unmixed populations. It has been common enough in the past, particularly on Hawaii, when the general level of all caterpillar populations reaches its maximum yearly development in spring, but it has always been found as a minor and insignificant component of the total population. On Kauai, the caterpillars were widespread over most young fields in one whole section of a plantation, and in one field of 88 acres they were abundant enough to harm young cane seriously. It is not possible yet to say whether this infestation heralds more to come, indicating a per-

manent change in the status of *Agrotis* and its parasites on Kauai, or whether it was due to a fortuitous and transient coincidence of circumstances which may never be repeated.

Armyworms reached a probable all-time low level of population this year. No caterpillars whatever were reported from the plantations, and only two minor outbreaks are known to have occurred in mauka grasslands, one in early spring on Kukaiau Ranch and another one, later in the year, on the Kohala Mountains. Both of these were quickly eliminated by parasites and diseases.

Anomala orientalis has been noticed in greater numbers than have been reported in many years. This is still very far from the abundance of 1930-1934 and has not been reflected in damage to cane. Such damage is not likely to appear, except very sporadically, in the presence of the *Scolia* wasp, the very efficient parasite of *Anomala*. It is not improbable, however, that the average level of *Anomala* populations has risen, or will rise somewhat in time, as a consequence of the intensive use of herbicides in cane and pineapple fields. Herbicides interfere with the enemies of *Anomala* by killing some and by eliminating plants upon whose nectar the survivors might feed.

INSECT COLLECTION GRADUALLY MOVING INTO NEW QUARTERS

A large part of the day to day work of the Entomology Department has continued to center on the care, enrichment and taxonomic study of its valuable collections. Although the job is far from finished, a large part of this collection has been transferred from Schmitt-type boxes to the museum cases obtained three years ago, and much of the material transferred has been rearranged in taxonomic order. This work is now greatly facilitated by the installation of proper lighting and the erection of metal shelves in the collection room (Figure 40).

The most valuable segment of the collection which remains to be rearranged is the "Hadden Collection," about 190 boxes of authoritatively-named material from Pacific areas. Until recently, legal title to this material had not been relinquished by Mr. Hadden, although it has been in the care and custody of the Station for years. This year a definite agreement with Hadden has removed legalistic obstacles to the integration of his material with the rest of the Station's collections, which will greatly facilitate its care and assure its preservation.



Figure 40. The collection room, showing Schmitt boxes on shelves and the museum-type metal cases to which the collection is being transferred.

LIGHT TRAPS LURE NEW INVADERS

The light traps at Waipio and Ewa have again shown their value in the early detection of newly-immigrant insects. Four out of a relatively short list of newcomers this year have first appeared in the traps and have not been detected elsewhere until considerably later. None of these four species is of direct concern to the sugar industry, but their early capture indicates the probable period of grace which will be granted for an all-out effort

toward eradication of any major cane pest which may reach Hawaii in the future.

Of the three traps used during the year, two are of a form widely employed elsewhere, but the third was designed in the department to accommodate a long fluorescent tube which burns more economically than other black or white light bulbs and which is attractive to a wider range of species (Figure 41).

THE MEALYBUG GIVEN CLOSE SCRUTINY

Detailed field studies on the bionomics of sugarcane mealybugs have been continued, and confirm the preliminary findings of last year. These are:

1. that some cane varieties provide a much more favorable environment for the development of mealybug populations than others. H 109, as shown in Figure 42, is far more favorable than 37-1933.

2. that mealybug populations reach their maximum at the end of summer and decline rapidly thereafter, as is also shown in the graph.

3. that the decline is due to increased parasite activity in dense populations of the host and to adverse effect of winter weather on mealybug reproduction.

In another phase of these investigations, it has

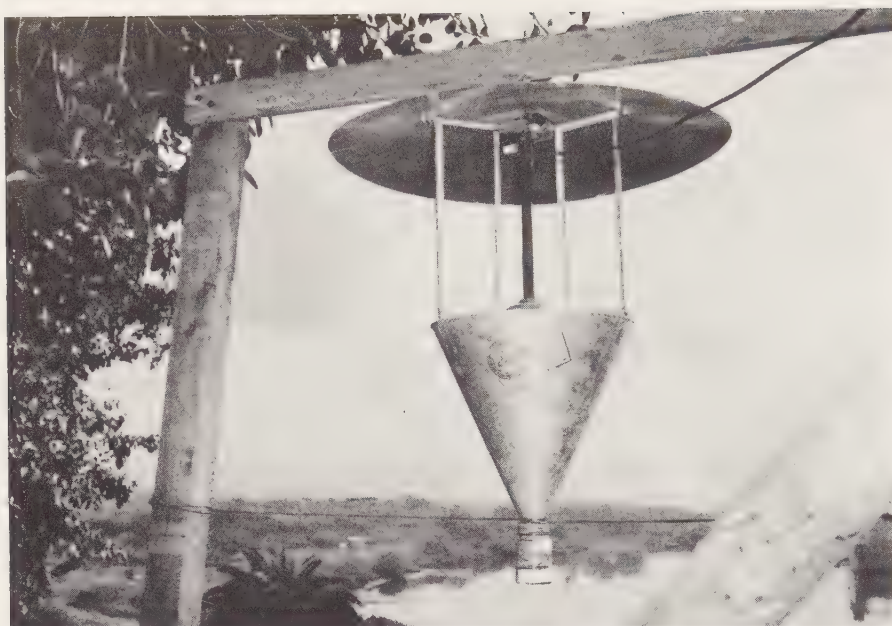


Figure 41. Light trap designed by the Entomology Department to employ a fluorescent tube whose light is attractive to a greater range of insects than ordinary black or white light.

been found possible to reduce mealybug populations to very small numbers by spraying individual cane stools with a 0.25 per cent emulsion of malathion every two weeks; but no practical means

are yet in sight to obtain the same result on a large scale. The chances of ever measuring the field losses due to mealybug feeding still seem, therefore, remote.

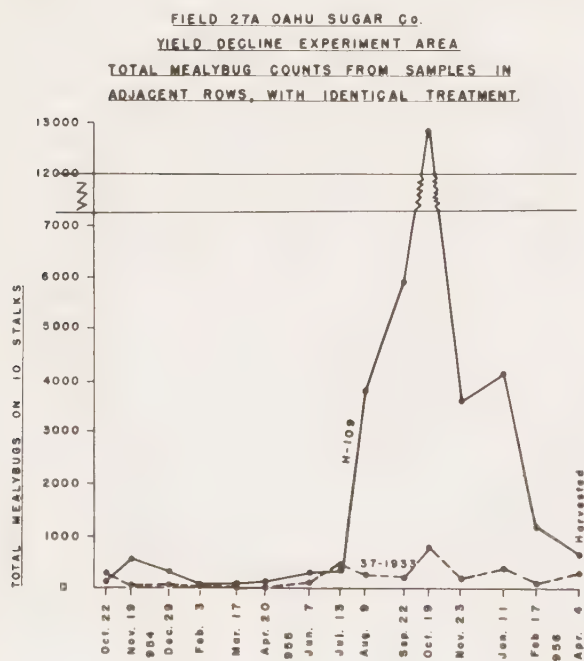


Figure 42. The yearly cycles of mealybug populations on two varieties of sugar cane are here compared on the basis of biweekly counts of the total number of mealybugs on 10 stalks of each variety, from adjacent cane rows, treated in identical manner.

MECHANIZATION

CUT-LOAD CANE HARVESTER IN FIELD BY LATE 1956

A cut-load machine for furrow-irrigated cane has been designed and is being constructed. It will be two-way by being double-ended and will have a continuous side discharge into a self-propelled transport. Two sets of operator controls are required. It is expected that a second operator will more than pay his way with added production. Designed into this machine are flexibility and semi-automatic features which facilitate accurate following of the furrow and control of cutting height.

Each cut-pickup-elevating conveyor is mounted so that the lower end can swing and oscillate within predetermined limits. With development, this feature should allow the cut-pickup end of the conveyor to follow the furrow without being accurately steered by the operator. It will also permit better cutting of curved lines. While operating, the gauging of the cutting height will be automatically controlled by means of gauge wheels and because of the fact that most of the weight is counterbalanced by the inactive conveyor. Low-alloy structural steels have been used where weight reduction could be effected; no aluminum alloys have been used.

With a two-way machine, there will be times when some cutting with a pronounced recumbency pattern will be required. The pickup reels and accurate cutting-height gauging will be aids to quality work in such conditions. However, more development may be required to meet this condition adequately.

When the machine is first field-tested, the cross-flow cut attachment on each elevating conveyor will cut every 36 inches of conveyor flow. This should give an average stalk length of approximately 38 inches. After being cut, the cane will drop onto the cross-load conveyor and will be carried up and into the transport traveling alongside. Soil and loose fines will be dropped through gaps in the elevating and cross-load conveyors.

Presently in the design stage is a second cross-load conveyor assembly which can be installed on the machine in place of the original conveyor. This assembly will accomplish considerable detrashing. The leaf trash removed will be left distributed over the field, and since brooming up of cane mixed with leaf trash would be impracticable, the harvester must leave very little cane on the ground.

For maximum detrashing and load density, the cane should be cut into shorter lengths than the cross-flow cut can accomplish unaided. Shorter average and maximum lengths can be accomplished by also cutting with the flow.

It is expected that this machine can be developed rapidly into a harvester as the first of three phases of the cut-load system. It is estimated that a complete system will also include the infield transport and transload phases. The harvested cane can then be cut and picked up as a continuous operation and sent to the mill without being put back onto the ground.

Part of the design of this cut-load machine has been aimed at determining how much can be done in coping with the problems of cutting and picking up furrow-irrigated cane. The greatest problem is short radius curves. This machine is expected to determine how short the radius can be for quality work. Then specifications for irrigation layouts which will allow for reasonably good machine-cutting can be set up. It is hoped that no opening-up will be required at the end of the cane line, as for instance along a road or a permanent irrigation ditch. Once the machine has been started in a field, the only opening-up which should be required will be firebreaks. If field layouts can approach the ideal for the characteristics of such a machine, the push-rake and grab can be completely eliminated. The wholehearted cooperation of all departments of a plantation will be required even to approach such an ideal situation.



Figure 43. Pickup transport in operation at Hilo Sugar.

Also to be determined is how much production with quality work can be attained with curved and hapa lines, if other conditions are reasonably good. The preliminary development should answer this

question. Flat culture has always been looked upon as very desirable in the long run, but the question of whether or not it is necessary for adequate production has not been settled.

INFIELD TRANSPORT FOR CUT-LOAD SYSTEM IN PLANNING STAGE

It is essential that the field be left in good physical shape when reasonable weather and soil-moisture conditions exist. Therefore, the transport following the harvester should, figuratively, float over the field. The Rolligon tire (Terra-Tire) which would operate with a pressure of five to eight p.s.i. looks promising. This tire has been developed to the point where it is axle-loaded and axle-driven, and available in several sizes, ranging up to 42-inch diameter by 60-inch width, and 60-

inch diameter by 42-inch width. The preliminary design of a unit using eight 60-inch diameter, 42-inch width tires has been made.

If it becomes necessary to use track assemblies, it is expected that four small assemblies which are steered would give the best results.

Loading of a highway transport directly by the harvester does not appear feasible, except in a few situations where large level fields and long lines exist.

TRANSLOAD FOR CUT-LOAD SYSTEM BEING EXPLORED

The roadside windrow system will be used for the first field operation of the cut-load machine. The windrowed cane will be grab-loaded into the highway transport. As the cut-load machine is developed into a harvester delivering detashed cane in short lengths to the transport, a proper transload system becomes more important. Exploratory work is under way to determine the best starting

point for this phase. The type and design of the transload equipment will affect the final body design of the cane buggy.

If a system of pumping cane from the field to the mill, which is now being investigated by HC&S, should become feasible, the infield transport could deliver cane to a pumping plant at the field edge.



Figure 44. HSPA cutter-transport equipped with pickup reel and cross-flow cut attachments operating in unburned cane.

PICKUP TRANSPORT FOR V-CUT CANE READY FOR FIELD TRIALS

The idea of a self-loading transport to pick up V-cut cane and transport it to a roadside was developed on Hawaii. The windrowed cane would be grab-loaded onto the highway transport. Some preliminary work was done with a cutter-transport from which the ground-cutting knife was removed. Indications were that V-cut cane could be picked up satisfactorily with a pickup conveyor. Estimates of costs and production by the interested plantations indicated economic possibilities. This has been a cooperative project with the C. Brewer and Company, Ltd., Engineering Department.

The prime mover is 108-inch gauge and similar to the Onomea-type units operating at Pepeekeo Sugar Company. The GM-471 engine is equipped with a torque converter. The body will be loaded

by a 45°-slope pickup-load conveyor assembly consisting of deck and overhead conveyors. The body has a conveyor bottom to aid in loading, and for unloading. Reduction of weight has been one aim of the project. The body and pickup-load conveyor frame are fabricated with structural and sheet aluminum alloy. Low-alloy structural steel has been used where its use allowed for weight reduction.

This project is aimed at determining the potential of a self-loading infield transport. It does not lend itself to reducing the lengths of the stalks or reducing the amount of leaf trash. However, it is expected that the tare will be reduced because the pickup will leave more leaf trash, soil, etc., on the ground than would be left by pushraking into windrows and grab loading (Figure 43).

CROSS-FLOW CUTTING PROVES SUCCESSFUL

The experimental cross-flow cut unit was first operated on the Kekaha harvester. In order to test the operation in unburned cane, the assembly was mounted on the HSPA cutter-transport (Figure 44).

Operation in unburned, dry-to-wet cane showed that no special problems were presented. Checking of stalk lengths indicated that an average minimum of approximately 38 inches could be expected. Shorter maximum and average lengths

would have to be obtained by adding cutting with the flow. The high percentage of loose leaf trash indicated that dry separation of leaf trash would be effective.

Based on field operation, the cross-flow cut as-

sembly was redesigned to reduce power loss, weight, and maintenance, and to increase ease of replacing sickles and other parts subject to wear. Two of the redesigned assemblies are being used on the cut-load machine.

POSITIVE PICKUP REDESIGNED

The design of the experimental pickup reel was changed to allow for a tube the width of the reel on the center of rotation. The tine bars are pulled from both ends, which reduces the maintenance

of the reel bearings. The slight increase in cost and weight has proved worthwhile.

Two of these assemblies are being used on the cut-load machine.

CUTTER-TRANSPORT REDUCED IN WEIGHT

A further revision of design and drawings of the cutter-transport has been made. The total weight of the machine has been reduced by about 5,000 pounds, giving an estimated weight of 24.5 tons. The weight has been so distributed that it is borne equally by each track assembly when the machine is on level ground.

The question is occasionally asked as to how

many drawings are required to build such a machine. The present set consists of 139 drawings with a total area of approximately 1,228 square feet. This is not enough to completely describe the machine. Certain things can be done effectively as work progresses if the fabricators are familiar with the machine and if the designers and draftsmen check the work from time to time.

CUTTER-WINDROWERS (SIDE MOUNTED) CONTINUE TO OPERATE SATISFACTORILY

Kaiwiki had a new cut-pickup-elevating-conveyor assembly fabricated from revised drawings, and installed on their side-mounted cutter-windrower. The results have been good.

There has been very little cooperative development work this year with Lihue and Hamakua Mill Company who also have this type of machine in operation.

METAL FLUME PICKUP MACHINE FOUND PROMISING

Some mechanical improvement has been made on the metal flume pick-up machine; however, further improvement is required on the nose assembly which lifts and spreads the cane off and

away from the flume. At Lihue, this machine has been found to be useful in the distributing and laying of metal flumes in both plant and ratoon fields.

ORGANIC CHEMISTRY

SUGARCANE CUTICLE WAX UNIQUE TO HAWAII

Recovery of wax alone from Hawaiian filter cake seems of doubtful value because of low yield and poor quality of the wax. The total organic extractives of filter cake or some components other than wax may be of more value.

Cane wash water is another source of the wax, unique to Hawaii and accounting in part for the low wax content of the filter cake. The mechanical agitation in the cane washers removes part of the powdery cuticle-wax coating which is carried out of the mill as part of the trash and dirt scums floating on the wash water. In ponded areas or still water areas of the cane cleaners, these scums can be skimmed off and the wax recovered. The amount of recoverable wax will vary greatly with harvesting practice, mill conditions, and possibly climate, cane variety and other factors.

Wash water scums have been collected in considerable quantity from Oahu Sugar and Ewa. Two independent estimates have been made from material taken from Oahu Sugar and from the Puunene mill of HC&S, indicating that about 1,000 pounds of cuticle wax is removed in the cane cleaner per day, or about 0.3 pounds per ton of cane milled.

Organic solvents are the only means yet found to remove the wax effectively from the carbon and trash particles. Preliminary settling or screening can be used to concentrate the wax particles; however, mechanical losses are proportionally high.

Samples have been sent to several mainland firms for industrial evaluation.

Infrared spectrophotometer analysis has given some unexpected results:

1. Cuticle wax scraped from growing cane stalks appears to be mostly saturated hydrocarbon and alcohol in nature.

2. Cuticle wax extracted from the wash water scums had a strong carbonyl group absorption at 5.7 and a carbon-oxygen absorption at 8.5 microns wave length.

3. Filter cake hard wax was similar to the cuticle wax described above, but the carbonyl bands were even stronger.

4. Either the powder wax coating on cane, hydrocarbon and alcohol in nature, is oxidized by burning, or there are other waxy, oxygen-containing substances present in the rind and interior portion of the cane which become part of the solvent-extracted wax.

ORGANIC EXTRACTIVES FROM FILTER CAKE EVALUATED

Major emphasis was placed on solvent extraction from filter cake of sufficient quantity of material so that two-pound samples could be sent to several mainland firms interested in mixed fats and sterols. No evaluation of the samples has been received as yet.

The solvent extractives (about four to seven per cent on dry cake) contain about 40 per cent wax and 60 per cent "cane oil" which is a complex

mixture of fats, sterols, resins, color-contributing materials, and other unidentified products.

Cane oil was hydrolyzed by alcoholic alkali, and the fatty acids were removed as the insoluble calcium salts. The recovered acids amounted to 43 per cent of the oil. About 0.5 per cent residual wax was removed and another 4.5 per cent recovered as a pale yellow solid which gave a very intense sterol test.

AMMONIATED BAGASSE PITH LOCKS PROMISING FOR CATTLE FEED

Bagasse pith is included as a minor proportion carrier of molasses in bagged stock feeds. It is de-

sirable to increase the amount of pith used and to increase its negligible nutritive value in such

feeds. Recent feeding tests show that reaction of ammonia with pith not only provides non-protein nitrogen in a utilizable form, but also alters the pith in such a way that the pith itself provides nutritive and palatable material.

Three methods of ammoniation are possible: first, reaction with aqueous ammonia at room temperature; second, reaction with aqueous ammonia at elevated temperatures and pressures; and third, reaction with anhydrous gaseous ammonia at elevated temperatures and pressures (Figure 45). The products appear to be different in each of the three cases. Results with Hawaiian pith do not follow those obtained by B. A. Bourne of the U. S. Sugar Corporation using Florida pith. The differences presumably arise from the age of the cane at harvest and a higher initial nitrogen content of the Florida bagasse.

The best conditions for producing feed for ruminant animals from bagasse pith, containing about 10 to 12 per cent protein equivalent (two per cent nitrogen), appear to be an initial pressure of 100 p.s.i. gaseous ammonia heated with pith to a maximum pressure of about 200 p.s.i. and maximum temperature of 100° C.

The University of Hawaii has tests under way on pith ammoniated by the Organic Chemistry Department intended to measure by the artificial rumen technique the utility value of the nitrogen and reacted pith for ruminant animals.

Large scale feeding trials are being conducted by Dr. L. F. Wiggins in Trinidad with the anhydrous ammonia product.

At two per cent nitrogen, ammoniated pith would have to sell for \$9 a ton to supply nitrogen

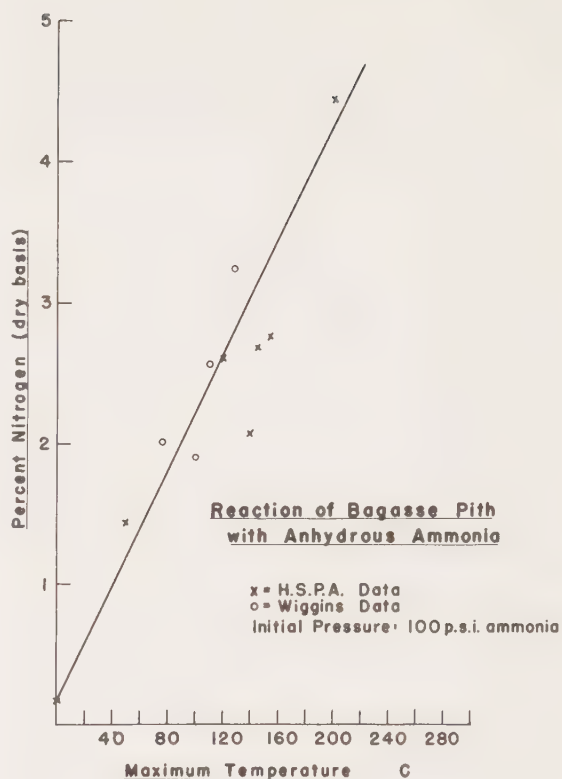


Figure 45.

at the same cost that feed-grade urea now does. It is evident then that the economic potentiality of this product will depend on the proportion of the pith that is utilizable in addition to the nitrogen. Considering the ammoniated product as a replacement for napier or other grass or hay, palatability would be a great factor in its acceptance, and the nitrogen values would need only to correspond to the roughage replaced.

PLASTIC MOLDING COMPOUNDS FROM AMMONIATED PITH

The ammoniation of bagasse pith apparently modifies the lignin component, lowering its flow temperature in such a way that the material can be molded, at about 150° to 190° C. and 1000 to 5000 p.s.i., to a brown-to-black particle board or

resin board which is very hard and dense. Its rather high water sensitivity can be lowered considerably by adding a small percentage of resin such as a phenolic. These materials are still in the early research stage.

MOISTURE EFFECTS ON PITH FOR CATTLE FEED STUDIED

Mill-discharged undried pith (40 to 50 per cent moisture) was used in the University of Hawaii's Ration 32 and tested for its keeping quality. Pith, cottonseed meal, pine bran, meat and bone meal,

dry urea, and salt, were mixed together in the suggested amounts. Molasses at 89-91 Brix was heated (below 160° F.) and mixed into the ration. The mixes were kept in multi-walled paper

bags and in burlap bags for a three-month test period. Temperature and humidity were recorded during the test period. There was no rise in temperature in the mixes, no fermented odor, and no mold formation. These preliminary studies showed justification for individual commercial mixers to look into the use of undried pith for cattle feed from the standpoint of confirmation and of determining how this use could be of benefit to their own operations.

Five mixes of this same ration were made with varying moisture contents of 12.42 per cent to 22.85 per cent. Mixes Nos. 4 and 5 with moisture contents of 21.65 per cent and 22.85 per cent, respectively, started to mold in seven weeks. At the end of three months, both mixes were heavily molded. Mix No. 3 with 19.70 per cent moisture developed one small spot of mold about one-eighth inch in diameter at the end of three months.

It was interesting to note that the difference in per cent moisture between mix No. 3 and mix No. 4 was only 1.95.

Water absorption characteristics of dried and undried pith were also studied. Although it was shown that dried pith would eventually absorb as much water as undried pith (40 to 50 per cent moisture), it would take a longer and more vigorous treatment.

Two hundred and fifty milligrams of water were added to 20 grams of undried pith with constant stirring. The mixture was allowed to stand for three minutes. It was then filtered through a sintered glass filter using suction for three minutes. Oven-dried pith was given the identical treatment. By this procedure, it was found that the dried pith absorbed only one-half as much water as the undried pith. These characteristics may be significant in commercial feed mixing operations.

MOLDED BOARD FROM BAGASSE PITH

Bagasse pith has been molded into a dense, hard, waterproof block of good appearance and properties. Excellent bonding was accomplished by use of a reactive chemical tolylene diisocyanate which reacts with hydroxyl containing substances such as water, alcohols, sugar, cellulose, etc., to form insoluble, infusible resins known as polyurethanes. This chemical compound is not commercially available, except in Germany, but by 1957 three U. S. concerns will be in commercial production. Its chief uses will be in synthetic rubber and synthetic rubber foams.

Dried pith reacted with the admixed diisocya-

nate when the mix was subjected to molding conditions of 120° to 130° C. and 1000 to 10,000 p.s.i. Table 5 summarizes some of the results obtained. Tensile and compression tests were run by the University of Hawaii, Department of Engineering, Materials Testing Laboratory.

It was important to dry the pith thoroughly before mixing with the diisocyanate to prevent bulging of the molded object due to gas formation. There was no tendency to stick to the mold. The blocks could be sawed and nailed like wood.

Cost of the diisocyanate component cannot be computed until it is available commercially.

TABLE 5
Reaction of Bagasse Pith with Tolylene Diisocyanate
Under Pressure Molding Conditions

Tolylene Diisocyanate (% /wt.)	Molding Conditions			Stress Tests (p.s.i.)	
	Temp. ° C.	Pressure p.s.i.	Time Min.	Average Tensile	Average Compression
5	130	10,000	6	1,154	3,544
10	130	10,000	6	2,090	4,583
20	130	10,000	6	2,220	4,786
Untempered Masonite.....	.....	.....	.....	3,295	2,945
Tempered Masonite.....	.....	.....	.....	4,895	2,690

VARIETIES

THE 1955-1956 CROSSING SEASON

The crossing season began on November 18, 1955, and ended on January 19, 1956. Tasseling in the Kailua breeding plots was lighter than usual, due possibly to subnormal temperatures during September, the period of tassel bud initiation. At the height of the crossing season, a destructive Kona storm which began on December 19 caused much damage, not only to crosses already under way but also to tassels which had not yet emerged.

Another storm on January 12 added to the destruction.

On the whole, the past crossing season was one of the most disappointing in many years. The partial or complete loss of many crosses necessitated stretching the successful crosses (Table 6). Thus certain crosses were extended to larger areas than would have been done had a wider choice been available.

TABLE 6
Number of Crosses Undertaken During 1955-56 Crossing Season

General melting pot crosses.....	1,575
Leeward melting pot crosses.....	538
Windward makai melting pot crosses.....	360
Windward mauka melting pot crosses.....	286
QR melting pot crosses.....	173
Bi-parental crosses	528
Field crosses	33
Total.....	3,493

PRELIMINARY TESTING AT THE REGIONAL STATIONS

Certain changes are being made in the regional station network (Figure 46) as follows:

1. Waipio Substation, originally scheduled for termination in 1957 at the expiration of the lease, is to be retained. With the renewal of the lease for a 30-year period, Waipio will continue to serve as the leeward makai seedling testing station.

2. The new Ewa and Helemano Makai stations, initiated as replacements for Waipio, have been returned to the respective plantations.

3. The 27-acre Waimano Mauka station above Pearl City lies in the path of a residential development. It is being replaced by a 30-acre station in the mauka lands of McBryde Sugar Company.

The testing program is also undergoing revision in certain details as follows:

1. The change from cut-and-pull harvesting to slash-cutting necessitates changing from six-line plots separated by blank lines to eight-line plots

without blank lines between plots. This change reduces by 40 per cent the number of seedlings that can be tested in a given area.

2. A disturbingly high proportion of the seedlings which have good juices at one year of age suffer from fracturing during lodging and deterioration during the second season, with consequent poor juices when harvested at two years of age. As a result, a great majority of the seedlings advanced to 40 x 40 testing on the basis of good growth and good juices at one year of age are failures when harvested at two years. This fact points to the need for evaluating the carrying-over ability and sucrose content of a larger number of seedlings under two-year cropping, in order to improve the chances of identifying individuals that are superior to the present standard varieties.

3. The reduction in the number of seedlings that can be tested in a given area when plot size

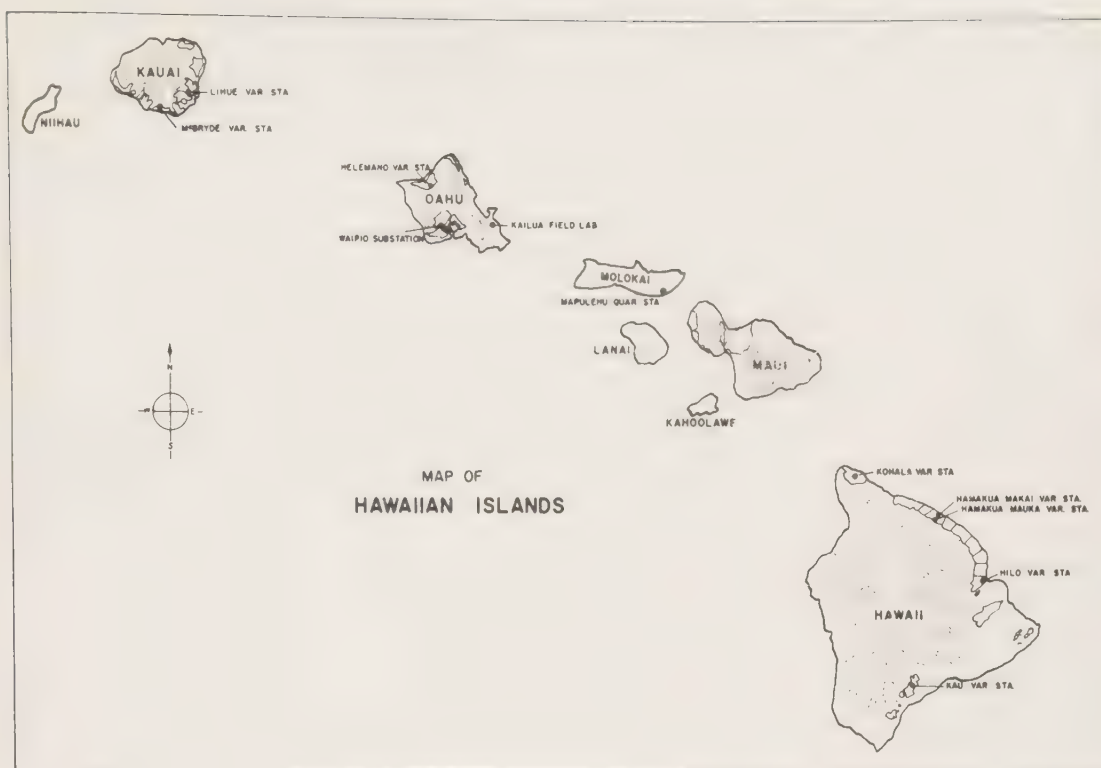


Figure 46. The Regional Variety Station network—1956.

is increased to permit slash-cutting, intensifies the need for an intervening stage in which larger numbers of seedlings can be evaluated under two-year cropping. In 1954, two 20 x 20 trials were installed, one at Waipio and the other at Waimano Mauka, to explore the possibilities and limitations of this innovation. These 20 x 20 trials were harvested during the past summer with encouraging results. It is now planned to devote to 20 x 20 trials, the area formerly occupied by 30 x 30 trials at the leeward irrigated stations. By so doing, the number of seedlings that can be tested for carrying-over ability and juice quality at two years will be twice the number that could be accommodated in 30 x 30, and four times the number that could be accommodated in 40 x 40.

4. Since the area at the regional stations is too limited to accommodate both the 20 x 20 and the 40 x 40 stages, the leeward irrigated stations will henceforth devote their available area to preliminary testing up to and including the 20 x 20 stage. The 40 x 40 trials will be installed in plantation

fields. Plantation 40 x 40 trials will eventually be comprised largely, if not entirely, of candidates which have demonstrated in 20 x 20 trials at the regional stations their suitability for two-year cropping.

5. To insure sufficient seed for planting a 20 x 20 plot, the 5 x 6 stage has been enlarged to 5 x 10.

6. In the past, seedlings showing promise at any one station were distributed for 5 x 6 testing to other stations in the network. Now that this stage is being enlarged to 5 x 10, the tonnage of seed to be packed and shipped would become unduly burdensome if inter-station shipments were to take the form of 5 x 10 plantings. Henceforth, only exceptionally promising seedlings will be shipped from one station to another as 5 x 10's; the bulk of future interstation exchanges will take the form of 5 x 3 shipments. Since a 5 x 3 plot requires only two seed pieces, this revision will greatly reduce the volume of seed to be cut, packed and transported. It will also permit distribution of selected seedlings to a larger number of stations.

It is believed that these revisions will achieve a more effective utilization of the regional station testing facilities.

The preliminary testing activities of the regional variety stations are summarized in Table 7. Omitted from the tabulation are the following:

1. Breeding and spreading canes at the Kailua Field Laboratory.
2. 2,849 numbered 5 x 3 plots at Kailua and Oahu Substations.

3. Field nurseries under special conditions on plantations:

Hutchinson	100 flats
Kohala	200 "
	300 "

4. 5 x 6 plots under special conditions on plantations:

Lihue	100 plots (5x6)
HC&S	152 " (5x6)
Hutchinson	31 " (5x7)
Paauhau	27 " (5x10)
	320

TABLE 7

Plantings Made in 1956 at Regional Stations

Regional Stations	No. of Flats (No. of Seedlings Per Flat 100-1000)	5'x3' No. of Seedling Plots	5'x10' No. of Seedling Plots	10'x20' No. of Seedling Plots	20'x20' No. of Seedling Plots	40'x40' No. of Seedling Plots
Kailua Field Laboratory.....	2,251	2,220	.....	.....	.....	.....
Waipio Substation.....	1,113	13,593	3,997	.....	74	.....
Waimano Mauka Variety Station.....	905	7,067	2,113	.....	74	.....
Helemano Variety Station.....	.....	2,649	1,090	.....	87	.....
Hilo Variety Station.....	287	7,939	1,682	103	.....	16
Hilo Mauka Variety Station.....	.....	1,064	45	32	.....	.....
Hamakua Makai Variety Station.....	300	538	1,782	100	.....	26
Hamakua Mauka Variety Station.....	150	1,281	1,366	112	.....	27
Kohala Variety Station.....	275	1,750	1,379	81	.....	20
Kau Variety Station.....	200	1,796	1,419	99	.....	20
Lihue Variety Station.....	372	2,549	1,378	82	.....	26
McBryde Variety Station.....	623	8,543	840	.....	76	.....
Total.....	6,476	50,989	17,091	609	311	135

VARIETY TESTING ON THE PLANTATIONS

Reduction in cost of harvesting variety tests and improvement in accuracy of yield data are being effected by the following developments:

1. A remarkable reduction in manpower requirement is realized in converting from the old cut-and-pull method of harvesting variety trials to the new slash-cutting procedure. This method is particularly effective in the hands of an experienced Island task force, such as those now operating on Oahu and Kauai.

2. The new pol ratio method for determining sucrose content of cane provides greater accuracy than the old quality ratio analysis of crusher juice. It has the further advantage of divorcing the sampling and analysis of the test plots from factory operations.

3. The cost of obtaining plot-by-plot cane weights is being reduced, and accuracy is being improved by on-the-spot weighing. Both Loadometer truck scales and Hydroway sling scales are being used to good advantage.

Returns from the investment in breeding were being seriously threatened by the steady decline of variety testing on the plantations. This decline was a natural result of the disappearance of skilled cane cutters and of the disruptive effect and high cost of harvesting variety trials with inexperienced personnel.

With the advent of these improved techniques, the long downward trend is being reversed and variety testing on the plantations promises to regain much of the ground which it has lost in recent years. The Island task force system, in particular, is showing promise as a means of improving the precision of field experiments with material reductions in cost.

Table 8 shows the number and distribution, by island, of preliminary trials installed by the plantations during the past year.

Table 9 lists the varieties which are being tested in replicated trials installed by the plantations during the past year.

TABLE 8
Number of Preliminary Tests Installed by Plantations 1955-1956
(Fiscal year ending June 30)

Type of Test	Kauai	Oahu	Maui	Hawaii	Total
10x15 and 10x20.....	20	8	8	32	68
30x30 and 40x40.....	16	10	5	18	49

TABLE 9
Replicated Variety Tests Installed by Plantations
July 1, 1955 to June 30, 1956

Variety	Kauai	Oahu	Maui	Hawaii	No. of Entries Total
37-1933.....	9	8	5	....	22
38-2915.....	1	10	5	8	24
39-5803.....	....	2	....	....	2
7028.....	6	1	....	....	7
41-1045.....	....	....	....	1	1
3340.....	....	....	....	5	5
44-2772.....	....	....	....	5	5
3098.....	....	2	....	13	15
3171.....	....	2	....	....	2
45-2608.....	3	2	1	....	6
46-564.....	....	....	....	1	1
48-527.....	....	....	....	1	1
546.....	1	....	....	1	2
4178.....	6	6	....	....	12
4605.....	1	....	....	....	1
4646.....	4	4	....	....	8
4899.....	2	....	....	....	2
49-5.....	3	1	....	11	15
104.....	....	....	....	15	15
118.....	....	....	....	2	2
134.....	5	1	....	8	14
612.....	....	....	....	2	2
722.....	....	....	....	1	1
3533.....	5	....	....	....	5
3637.....	2	....	....	....	2
50-723.....	....	....	....	1	1
52-243.....	....	....	....	1	1
Totals for					
1955-1956.....	48	39	11	76	174
1954-1955.....	14	13	2	63	92
1953-1954.....	24	7	....	48	79

AUGMENTED BLOCK DESIGNS PERMIT MORE EFFICIENT TESTING

Until recently, preliminary (unreplicated) and semi-final and final (replicated) variety trials have been conducted separately. Replicated trials have employed one-tenth to one-thirtieth acre plots. Preliminary trials have employed one-fortieth acre plots, the unreplicated seedling plots being interspersed at regular intervals with check plots of the standard variety.

Thus in a typical preliminary trial of this type, one-third to one-fifth of the area in the test was occupied by check plots. Such a design offered the

advantage of an intimate comparison in growth habit and yield of the new seedlings and the standard variety against which they were competing. So long as all of the cane on the plantation was being harvested by hand, the liberal use of check plots added but little to the cost.

With the disappearance of hand cutting from the plantations, the plot-by-plot harvesting of yield trials became more difficult and more costly. Dr. Walter Federer, Department of Experimental Statistics, in a study of preliminary variety tests at

Waipio, called attention to the inefficiency and costliness of a design in which one-third or one-fourth of the plots were check plots.

In regions where two or more varieties are competing for leadership, such competitors have sometimes been employed as alternate checks in preliminary trials. This procedure offers the advantage of providing a replicated yield comparison of the competing checks while providing a good standard against which the new unreplicated seedlings could be measured.

Dr. Federer has pointed out the advantages to be gained by extending and formalizing the latter procedure. This entails combining replicated and unreplicated testing in a single test of intermediate plot size, usually 40 x 40 or one twenty-fifth acre each. The result is the *augmented block design*, originally called a chain block design.

In a typical augmented block trial, the standard variety (X) and two strong competitors (A) and

(B) are pitted against each other in five blocks, to give five replications of each. Each of the five blocks will include also six new seedlings which are being tested in single (unreplicated) plots. Thus the five blocks will include a total of 30 new seedlings, for which the three replicated varieties in each block will provide an adequate standard.

In the above example, an augmented block layout of 45 plots provides as much information as could be had from a total of 60 plots under the former procedure, which would have involved two separate tests as follows:

<i>Replicated Test</i>	
5 plots each of 3 varieties.....	15 plots
<i>Preliminary Test</i>	
30 new seedlings plus 15 check plots....	45 plots
Total.....	60 plots

In view of the substantial savings offered by the augmented block designs, it is hoped that this improvement will be widely adopted in the plantation seedling testing program.

DISTRIBUTION OF SEED

In addition to their testing functions, the regional variety stations serve as distributing centers which supply the plantation testing programs with

seed of the new seedlings which are worthy contenders. The details of this activity are shown in Table 10.

TABLE 10
Seed Shipments to Plantations
(July 1, 1955 to June 30, 1956)

Source	For Seed Nurseries—Tons	For Grade A Tests—Tons	For 10x20 No. of Plots	For 30x30 and 40x40 No. of Plots
Kailua Field Laboratory.....	.60	.....	.....	.....
Waipio Substation.....	3.68	.....	1,525	30
Waimano Mauka Variety Station.....	.43	.....	124	27
Ewa Variety Station.....	.....	.....	.....	39
Hilo Variety Station.....	1.18	.....	805	12
Hamakua Makai Variety Station.....	4.18	.....	1,155	.....
Hamakua Mauka Variety Station.....	.....	.....	191	.....
Kohala Variety Station.....	.11	.....	18	.....
Kau Variety Station.....	.08	.....	28	.....
Lihue Variety Station.....	.20	.30	13	.....
Totals	10.46	.30	3,859	108
Total 1954-1955	27.71	5.58	3,508	129

CYTOLOGICAL INVESTIGATIONS

Investigations on the cytogenetics of sugar cane under a cooperative USDA-HSPA project have made good progress during the year. Dr. Samuel Price spent the past tasseling season in Hawaii collecting pollen mother cell material from the breeding collection at the Kailua Field Laboratory

for cytological study. During the year, Dr. Price has reported chromosome counts on nearly 200 clones in the USDA and HSPA breeding collections and has published three papers covering various aspects of his findings in scientific journals.

EVALUATION OF BREEDING BEHAVIOR

A summary of seedlings reaching the 10 x 20 stage of testing provides a basis for evaluating the parent canes used in breeding. The following parents have been found to be well above average in respect to the percentage of their seedlings which have qualified for the 10 x 20 or later stages of testing; they may therefore be classed as elite parents: 39-4253, 39-4753, 39-7028, 41-3340, 41-3620, 42-19, 43-990, 44-2364, 44-2772, 44-3098, 44-3228, 45-385, 45-1361, 45-2507, 46-564, 46-919, 46-2113, 46-2404, 46-2731, 46-3488, 47-1914, 47-2413, 47-2800, 47-4991, 48-160, 48-3432, 48-4709, 49-104, 49-118, 49-662, 49-3079 and 49-3646.

ACREAGE CENSUS OF CANE VARIETIES

The area planted during 1955 totalled 29,732 acres. The rate of plowing and planting on Kauai and Hawaii was nearly twice that on Oahu and Maui.

For the fifth consecutive year, 44-3098 led in acreage planted. New plantings of this variety totalled 9,677 acres, of which 9,278 acres were planted on Hawaii. 37-1933 again occupies second place with 5,182 acres planted. This acreage is well distributed over the irrigated lands of Kauai, Oahu and Maui. 38-2915 remains in third place, with 4,690 acres, planted mainly on Oahu and Maui. 39-7028, in fourth place, was planted to 4,177 acres, all on windward Kauai, with the exception of 419 acres in the Kapoho district of Olaa. 44-2772 has risen to fifth place, with 1,656 acres planted in the mauka lands of Hawaii from Kohala to, and including, Laupahoehoe. 41-3340, in sixth place with 1,513 acres, was planted in the droughty makai lands of Kohala and Kau. The two leaders of a few years ago, 32-8560 and 32-

The bi-parental crossing program is concentrated upon crosses which bring together the elite parents listed above, with particular emphasis upon combinations in which the strong and weak points of the two parents complement each other.

It is highly probable that for the immediate future, more rapid progress could be realized by restricting the breeding program to the elite group of parents. However, the apparent susceptibility of many Hawaiian varieties to certain foreign cane diseases underlines the importance of augmenting genetic diversity and incorporating disease resistance from outside sources as new breeding material becomes available.

1063, have all but disappeared from the planting program. No 32-1063 and only 177 acres of 32-8560 were planted during 1955.

Among the newcomers are 49-104 and 49-134, getting under way on Hawaii with 305 and 223 acres, respectively, 45-2608 with 62 acres in the better irrigated lands of Oahu and Maui, and 49-118 with 54 acres in the mauka lands of Kau.

While 37-1933 has passed its peak, it remains the leader in terms of total acreage, which now stands at 69,706 acres, reflecting a loss of 1,501 acres during 1955. 44-3098, in second place, gained 4,007 acres to bring its total to 57,694 acres. 38-2915, in third place, with 38,633 acres, appears to have passed its zenith; it lost 51 acres during the year. 39-7028, with 11,812 acres, gained 3,134 acres and moved from sixth to fourth place. 32-8560 and 32-1063, in fifth and sixth place, respectively, continue to decline rapidly. 32-8560 lost 3,445 acres during 1955, while 32-1063 lost 4,720 acres.

THE VARIETY PICTURE—1956

Sugarcane farming as practiced in Hawaii, where a single variety may occupy large areas for six or more years at a stretch without benefit of rotation, fallow or soil fumigation, is peculiarly vulnerable to any bacterium, fungus or nematode that can attack the variety being grown. It has been abundantly demonstrated that an erstwhile resistant variety may eventually succumb to a new strain

of pathogen, and that pathogens can and do hybridize and mutate to give rise to new, and sometimes to more virulent, strains.

In the face of a dynamic pathogen complex, it is no more than prudent to have in readiness, as insurance against loss from yield decline, varieties that can be used to replace the standards if the latter should begin to fail. A major objective of

the breeding and testing program is to ensure that replacements for each of the standard varieties will be available if and when needed.

The following appraisal of the current situation is based upon yield data from preliminary tests (30 x 30 and 40 x 40) at the regional variety stations, and from preliminary and replicated tests harvested on the plantations. The major ecological zones will be considered in geographical order.

Windward Kauai—Mauka Unirrigated

39-7028 has become the major variety. 38-2915 was replaced rapidly when it began to succumb to red rot. 39-4753 and 45-2120 are regarded as standbys.

Other candidates for testing: 47-1992, 48-4605, 49-5, 50-2606, 51-2530 and 51-4336.

The scarcity of candidates emphasizes the need for more intensive testing in this region.

Windward Kauai—Irrigated

39-7028 continues to gain in area. Because of its tendency toward poor juices, it is not well suited to situations conducive to rank growth. 45-2708 is a standby for such situations. Its freedom from tasseling, good juices, and sound condition at harvest, confer advantages for long cropping at the beginning and end of the harvesting season. 48-4178 shows promise for rank growing, poor juice spots; it is a non-tasseler with excellent juices, but somewhat deficient in cane tonnage. 48-4605 has repeatedly demonstrated its yielding ability; it appears that this variety could serve as a replacement in much of the area now occupied by 39-7028 with little or no loss in yield.

Other candidates for testing: 45-2608, 45-2860, 47-1992, 48-546, 48-4899, 49-5, 49-134, 49-3404, 49-3533, 49-3666, 49-3945, 50-2036, 50-2606, 50-7209, 51-2530 and 51-4336.

Leeward Irrigated—Mauka and Middle Belt

38-2915 continues to gain in area at the expense of 37-1933 and 44-3098. 37-1933 is holding its own, however, in the more fertile areas which are well supplied with irrigation water.

The following have equalled or outyielded 38-2915 in a number of trials: 45-2608, 48-4646, 49-3533 and 50-2036.

Other candidates for testing: 45-2860, 48-3845, 49-5, 49-104, 49-118, 49-134, 49-3666, 49-3961, 49-4314, 50-2606, 50-7209 and 51-4964.

Leeward Irrigated—Makai

37-1933 remains the standard; only in situations where it is not at its best is it giving way to 38-2915. 39-5803 is a good standby for the marine flats of leeward Kauai and Oahu. 45-2608 and 49-3533 have repeatedly equalled or outyielded 37-1933 under good growing conditions. 49-3637 has shown good salt tolerance in the saline spots of the Kekaha flats. 44-3171, a high sucrose cane, has outyielded 37-1933 at Kahuku.

Other candidates for testing: 48-3845, 48-4178, 48-4646, 49-5, 49-104, 49-134, 49-3945, 49-3961, 49-4267, 49-4314, 50-2036, 50-2606, 50-7209 and 51-4964.

Hamakua and Kohala—Mauka

44-2772 is displacing 38-2915 and 38-4443 as the standard except in the poorest extreme mauka fields, where 38-4443 is difficult to equal. 46-525, 46-564 and 49-784 are standbys; the latter two are somewhat below par in juice quality.

Other candidates for testing: 41-1045, 49-612 and 50-2746.

Hamakua and Kohala—Middle Belt

38-2915 is giving way to 44-2772 in poorer areas. 44-3098 continues to do well in the better lands, but is encountering competition from 49-104 and 49-5 which have yielded well and which are somewhat superior in juice quality. 39-4753, which occupies large areas in the Kohala middle belt, is being replaced by 41-3340 in the droughty areas and by 49-104 in the better areas. 49-5 shows promise under a wide range of conditions.

Other candidates for testing: 41-1045, 45-2654, 49-134, 50-111, 50-2036 and 51-760.

Hamakua and Kohala Makai

38-2915, 41-3340 and 44-3098 are the standard varieties. 45-2120 and 46-564 are good standbys for drought areas. 41-3340 is favored in droughty situations. 44-3098 continues to do well in the better areas where drought is not severe. 49-104 has yielded well and is being extended. 49-134 continues to show promise in non-droughty areas. 49-5, while not yet adequately tested, appears exceptionally promising.

Other candidates for testing: 45-2654, 48-527, 48-546, 50-2036, 50-2606 and 50-7209.

Hilo Mauka

44-3098 is difficult to equal in this region, but 44-2772, 49-5 and 50-723 are affording stiff com-

petition. The good juice record of 49-5 makes it especially attractive.

Other candidates for testing: 41-1045, 50-111 and 50-2036.

The scarcity of candidates emphasizes the need for more intensive testing in this region.

Hilo—Middle and Makai

44-3098 remains the standard. 45-2708 is a good standby for the more fertile fields, particularly under long cropping. 49-5, 49-104 and 49-134 have yielded well in a number of trials. Results to date indicate that for best results, 49-134 must be cropped at somewhat less than 24 months.

Other candidates for testing: 48-3594, 49-3404, 50-111, 50-723 and 51-1047.

Kau Mauka

44-3098 is the standard, with some 46-564 in

the poorer areas. 49-5 and 49-118 have yielded well and are being spread.

Other candidates for testing: 44-2772, 49-3646 and 50-723.

Kau Middle Belt

44-3098 occupies the better lands with some 38-2915 in areas of thin soil. 49-5 and 49-118 are being spread on the basis of their excellent yields in preliminary trials.

Other candidates for testing: 41-1045, 44-2772, 49-3646 and 50-723.

Kau Makai

41-3340 is the standard with 46-564 and 45-2120 as standbys.

Other candidates for testing: 46-945, 49-5 and 49-118.

CANE FLOWERING CONTROL REACHES PRACTICAL STAGE

Flower control was successfully applied to many hundreds of acres last fall. This was done primarily by withdrawal of irrigation water, and harvest results indicate that the temporary setback due to skipping two or three irrigation rounds is more than compensated by improved development of unflowered cane. The usual results are more cane per acre and improved quality. The latter figure is almost invariably significantly improved. Table 11 gives summaries sent in from two plantations this year.

At Makiki, new results greatly extend knowledge about chemical and water control. Exact timing remains a primary factor for success. Almost complete control resulted from the drying off from August 9 to September 23. Earlier drying reduced

flowers more than did late drying. Hence, it is better to be early than late. Added nitrogen reduced flowering from 50 to 20 per cent. However, this may be more apparent than real. The final stalk counts were made March 15, 1956. During the 7.5 month period after adding nitrogen, more new stalks came to size for counting, thus reducing percentages of stalks old enough to flower in September.

This is illustrated in Table 12, where 20 large stalks, tagged in August, constitute a plot. Flowering with and without added nitrogen was 80 and 90 per cent, respectively. The greater effect of nitrogen with drying off indicates that a combination of the two treatments would give optimum flower control.

TABLE 11
Harvest Results of Some Recent Flower Controls by Drying Off

Wailuku, Exp. 123TC				
Treatment	TCA	A.R.	P% C	TPA
Plantation Practice	118.9	7.0	14.3	17.0
2 Rounds Irrigation	125.9	6.7	15.0	18.8
Withheld August-September				
Lihue, Data of 5 Experiments				
Treatment	TCA	A.R.	Y% C	TSA
Plantation Practice	97.2	9.6	10.4	10.1
42 days drought.....	100.9	9.3	10.8	10.8

TABLE 12

Effect of Nitrogen level and time of drought on flowering of 20 large stalks, selected in August. All plots received 100# N/A at ratooning, January 24. High N Plots another 100# N/A, August 1.

Treatments	Per Cent Flowering
Low N Check.....	90
High N Check.....	80
Low N without water July 15–August 31.....	65
High N without water July 15–August 31.....	30
Low N without water August 9–September 23.....	5
High N without water August 9–September 23.....	0
Low N without water September 2–October 19.....	95
High N without water September 2–October 19.....	30



DEFOLIATION DATES	6	5	4	3	2	X	TASSEL CONTROL
2 8/15,22 8/29	8/15 TO 9/1	9/8	9/15	9/22	9/29		100 %
3 8/22, 29 9/16	8/22 TO 9/8	9/15	9/22	9/29			100 %
4 8/29 9/6, 12	8/29 TO 9/15	9/22	9/29				100 %
5 9/6, 12 9/19	9/6 TO 9/22	9/29					67 %
6 9/12, 19 9/26	9/12 TO 9/29						0 %

Figure 47 shows (1) that the very young leaves are most effective in inducing flower buds, and (2) that the effective time is early September, which is in agreement with results of night lighting and withholding water.

Corrosive chemicals were sprayed at high dosages to simulate defoliation. Endothal was completely effective at the 10-gallon per acre level; Versene at 30 pounds per acre. Salt, calcium, chloride, and syrupy phosphoric acid were less effective.

Of 13 chemicals sprayed at hormone-like levels, CMU again took first place with complete control at the five pounds per acre level and fair control at the two pounds per acre level. Versene and amino triazole are next in line. Maleic hydrazide gave much poorer control than usual this year at Makiki.

Figure 47. Severing the spindle blades at the level of the top dewlap in any of the three successive weeks, starting on August 15, completely prevents flowering; starting on September 5, there is only partial control; and a start on September 12 is too late to have any effect.

WATER DEVELOPMENT

NEW EVIDENCE IN WAINIHA GEOLOGY

The flood of February 1956 destroyed McBryde's intake dam on the Wainiha River, Kauai, and flooded the Wainiha powerhouse, so that the aqueduct was dry for several weeks.

During that period, an inspection was made of the tunnel system which, with subsequent mapping, disclosed several geologic details previously unrecognized. A mass of very dense rock, thought

to be a volcanic neck, was proved to be a valley-filling mass of posterosional lava, and two similar, heretofore unrecognized masses were found. The difference in distribution of dikes confirmed the presence of the caldera boundary where previously mapped. The dense dike distribution was proved to extend much further seaward than hitherto recognized.

SURFACE-WATER STUDIES AT KILAUEA

The principal siphon, many flumes, and considerable sections of open ditch on Kilauea's Princeville Ditch, were destroyed or severely damaged during record storms in November 1955 and February 1956. The Princeville Ditch supply was important, not only to Kilauea plantation but to Lihue plantation, as a possible source of water for lands between Moloaa and Anahola that are now

in pineapples, but in which rotation with sugar cane would be advantageous.

A study of the flow-time relations of the Princeville Ditch and the Kalihiwai River from which it takes its water was made as a basis for deciding whether to rebuild the ditch, and for what capacity to design the new siphon. Because of inadequate stream and ditch flow records, the study had to

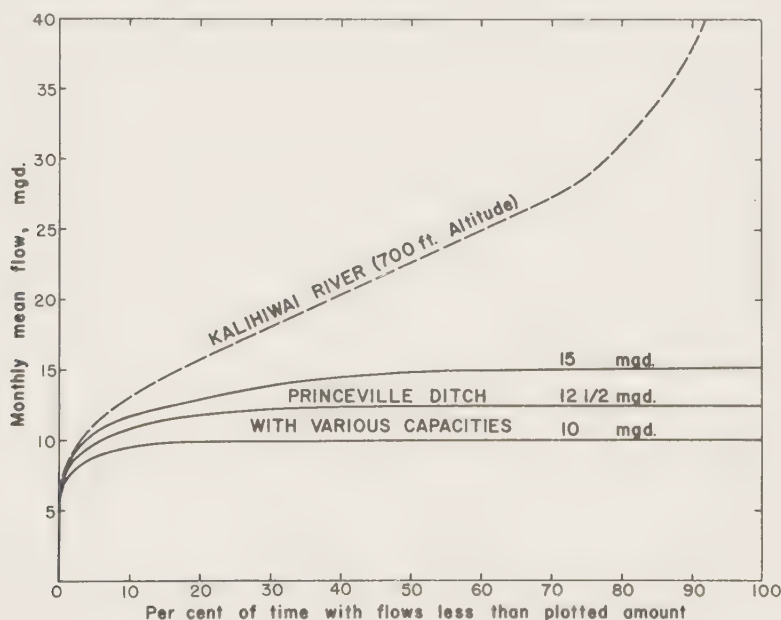


Figure 48. Duration-discharge relations for Kalihiwai River and Princeville ditch, Kilauea, Kauai.

involve a comparison of flows between Kalihiwai and Hanalei Rivers. The duration-discharge relations computed for the river and for ditches of various capacities are indicated in Figure 48. The low flows available through the ditch are insufficient to supply both the Kilauea needs and the prospective needs in Moloaa, but additional supplies made available by boosting from the river at the siphon might have been sufficient for both. However, the transport of Kalihiwai water across

Kilauea plantation to Moloaa was ruled out on economic grounds.

Moloaa Stream has also been investigated as a possible source of more water for the east part of Kilauea plantation and possibly the Moloaa lands as well. No flow records exist, so the flow must be estimated from rainfall. There is a possible site for a seasonal storage reservoir. One important tributary of Moloaa Stream was found that is not shown on the topographic maps.

KEKAHA WELL HYDROLOGY

The successful commercial growth of sugar cane on the Mana coastal plain of Kauai has depended, since its beginning in 1878, on basal ground water, partly artesian in character, developed by wells drilled on the plain or dug to bedrock at the base of the cliffs bordering the mauka edge of the plain. About 90 wells have been drilled on the plain, many so long ago that their characteristics and locations have been forgotten and even their existence is in doubt. To permit identification, recovery, and proper sealing of lost wells, and to

discover as much as possible of the relation between the initiation and changes in rate of draft and the resulting modifications in the characteristics of the ground-water body, a study and compilation has been made of all the old well records available, and a search for the old wells has begun.

Many of the drilled wells still in use are in poor condition. To take their place and to augment the supply of irrigation water, two new additions to the five Maui wells now in the area are under construction.

WAIALUA PUMP 4 EXPANDED

Because of good surface water supplies, the testing of the recently completed expansion of Waialua Pump 4 at Kawaihoa was delayed until late in the year. The expansion consists of seven new drilled wells of shallow depth connected by a trench, instead of the skimming tunnel that has been the usual means of development where the

head is as low as it is at Kawaihoa, about four feet (Figure 49). The expanded system provides a capacity of 14 mgd, with a drawdown of 1.0 foot compared with a former capacity of 8 to 9 mgd, with a drawdown of 1.2 feet. Salinity has not yet been a problem, though this year's pumping is not an adequate test of salinity results.

MOLOAA TEST WELL DRILLED

A nine-inch test well was drilled for Lihue in the most promising location at about 250 feet altitude in the lands between Moloaa and Anahola Valleys on Kauai, as a test of the possibility of developing ground water for irrigation so that cane might be planted in rotation with the pineapples now grown on those lands. A diamond-drill hole had previously indicated that the lavas to be encountered were members of the pre-erosional series of Kauai, but of unusually low permeability for those lavas. The well was deepened to 700 feet. A four-day airlift test at 0.4 mgd, on the 700-foot well showed a drawdown of 11.5 feet from

the initial 53-foot head at the well, with a drawdown at a nearby diamond-drill hole nearly paralleling that at the well after the first hour and reaching 5.5 feet. At the end of the test, the drawdowns were still increasing by about one-half foot per day.

These results indicate that the well is in a fairly small ground-water compartment, probably limited seaward by post-erosional lavas and quite likely isolated by dikes in other directions. Though the possibility of obtaining the desired 1.5 or 2 mgd, was not completely ruled out, the chances seemed too slight to justify the enlargement of the well.



Figure 49. New collecting trench
at Waialua Pump 4, Oahu.

MAUI-TYPE WELLS BEING CONSTRUCTED AT KEKAHA

To replace and supplement the ground-water supply from old drilled wells, Kekaha is constructing two new Maui wells, one at Saki Mana and one at Kaunalewa. The skimming tunnels will be driven into the bedrock cliffs bordering the

Mana coastal plain. It was hoped that bulldozer trenching of the overlapping talus would permit the shafts to be sunk in or into bedrock, but the Saki Mana shaft, which is now completed, is still in talus at sea level.

ROAD MATERIAL FROM BEACHES AND REEFS

Studies were made of boring results at a number of reefs on Kauai that were regarded as potential sources of road material for Lihue, to be worked by dredging. Biological studies by P. Helfrich and A. J. Kohn of the University of Hawaii suggested some benefits and no great detriments from the dredging operation proposed on the north Kapaa reef. Studies in cooperation with D. L. Inman of Scripps Institution of Oceanography suggested that a breakwater might have to be installed to assure a stable shore line behind the excavation.

Subsequently, about 300,000 cubic yards of coral and sand were dredged from Nawiliwili Bay for Lihue and stockpiled on a new-made peninsula in the harbor, pending use on the roads. This amount will take care of the needs in the southern part of the plantation only, and additional sources must be developed to take care of the northern part.

Dr. Inman's beach studies were extended to beaches elsewhere in the Islands to contribute to general knowledge concerning the problems of beach sand supplies and beach recession.

LANDSLIDING ON PRINCEVILLE DITCH

Some of the most severe damage caused to the Kilauea Princeville Ditch by the storms of 1955-1956 was the collapse of a number of high flumes

in an area on the west side of Kalihiwai Valley in which there has been repeated damage to both flumes and open ditch. This section of the ditch

crosses a landslide, in which movement during and after the storms opened many fissures about a foot across and with vertical displacements of about a foot. At first it seemed likely that the whole mass might move out into Kalihiwai Valley within a few months or years. More detailed work indi-

cated that the slide is fairly shallow and has been in movement for a long period, and that rapid movement is unlikely.

The plantation has taken a calculated risk and reinstalled the ditch on a wide bench cut into the slide material.

MINERAL DEPOSITS ATTRACT MAINLAND FIRMS

Brief assistance was given to the research team of Arthur D. Little, Inc., which has contracted with the Territory's Economic Planning and Coordination Committee to survey the economic mineral potentialities of the Islands. The report of the team has not yet been released, but wide publicity given to the mining possibilities make some comment on the situation desirable.

There can be no question that certain Hawaiian soils of sufficient extent contain sufficient titanium or aluminum in such chemical and physical condition as to constitute economic, or nearly economic, deposits. A large amount of exploration has been and is now being devoted to these

mineral deposits by various mainland mining companies. The land owners and the Territory do not, however, have sufficient knowledge of the grade and extent of the deposits to negotiate intelligent mining contracts with these companies.

The sugar industry has a clear interest in the development of sensible laws and policies governing mineral rights and mining. Some of the soils of interest are on lands owned in fee simple by sugar plantations, with ownership of the mineral rights in some cases uncertain. Others are on lands leased by sugar plantations. Some are on agricultural soils, and most of the rest are in important watershed areas.

WEATHER

RAINFALL RECORD COMPILATION TRANSFERRED TO WEATHER BUREAU

Beginning in January 1948, the Meteorology Department, cooperative with Pineapple Research Institute, initiated a program of collecting, collating, and binding for reference and research purposes, all rainfall records that were currently being kept in the Territory. Up to that date, no agency had undertaken such a comprehensive program, and a great many reliable and valuable records had been lost. Plantations and cooperators were supplied with individual record books with carbon-copy sheets to be removed as filled in for transmittal to the Department. The records for over 800 stations have been compiled for 8.5 years in this fashion.

The U. S. Weather Bureau has now agreed to take over the responsibility for collecting and collating the records for all the rain gauges, and for the continued preparation of IBM punch cards covering the data from 200 selected gauges. The Bureau will continue to exercise supervision

and inspection of its official list of "cooperative gauges."

Monthly Weather Forecasts Discontinued

Because most plantations believed that the experimental month-ahead forecasts were not sufficiently accurate to be of value, the general distribution of these forecasts was discontinued in January 1956, although they are still being prepared by the Weather Bureau.

Daily Forecasts Continued by Weather Bureau

Daily quantitative weather forecasts were initiated on Oahu in 1948, and in sections of other islands at later dates. These forecasts were prepared by the U. S. Weather Bureau in cooperation with, and after research by, the Meteorology Department; the department has since carried on evaluation of them. They are now being continued by the Weather Bureau alone.

REMARKABLE STORMS ON KAUAI

The island of Kauai, particularly the northern and eastern parts, experienced a remarkable series of rain storms during the 1955-1956 winter. The heaviest rainfalls occurred from November 8-12, 1955, January 24-25, 1956, and February 16-18, 1956, as follows:

Maximum Total Rainfall		
November 1955	Kilauea Office	26.1 in.
January 1956	Kilauea Office	44.9 in.
February 1956	Wainiha Power House	37.6 in.

The distribution of the rainfall for the first two storms is indicated by accompanying isohyetal maps (Figure 50). The February storm was more localized than the others.

The maximum rainfall rates at Kilauea during the January storm were as follows:

Duration	Rainfall
½ hour	6 in. (measured)
1 "	11½ in. (estimated)
6 "	16+ in. (estimated)
12 "	21+ in. (estimated)
24 "	38+ in. (estimated)
30 "	41.9 in. (measured)
48 "	43.5 in. (measured)

The measured figures are all local records and the estimated figures suggest that the rainfall for certain periods was comparable to, or even exceeded, Hawaiian and world record rainfalls. Many local records were broken.

Together, these storms did over \$750,000 damage on the island. Kilauea, which was the center of the two storms, was hardest hit. The mill was flooded twice, fields were stripped of top soil, ditches were washed out or silted up, and roads were washed out.

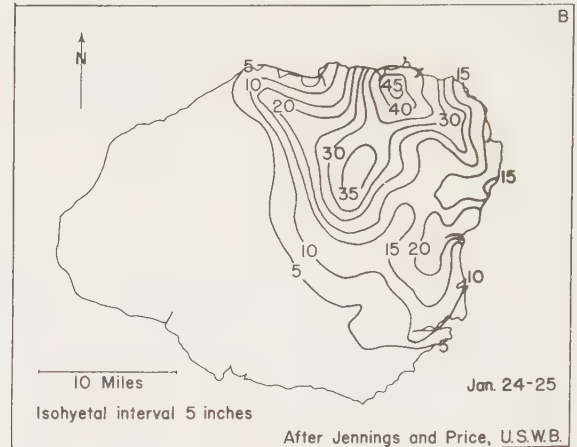
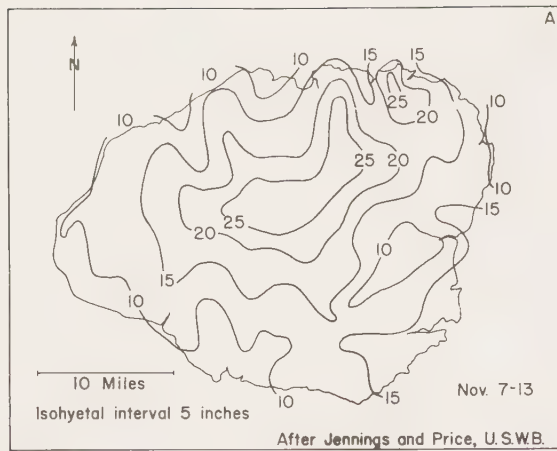


Figure 50. Isohyetal maps for the rain storms of November 7-13, 1955, and January 24-25, 1956, on Kauai.

MOISTURE CONSUMPTION STUDIES INITIATED AT PINEAPPLE RESEARCH INSTITUTE FIELD STATION

In a cooperative project between the Experiment Station, HSPA, and PRI, reported by Paul C. Ekern of PRI, the moisture consumption by pan evaporation, and evapotranspiration by Bermuda grass and pineapple (plant crop, summer of 1956) irrigated weekly, showed the following comparative rates in inches per month:

	Feb.	Mar.	Apr.	May	June	July	Aug.
Pineapple	1.25	1.55	1.80	2.29	2.40	2.42	3.16
Bermuda Grass		1.86	2.58	3.35	3.30	3.69	3.78
Pan Evaporation....	4.00	6.00	6.60	7.53	6.90	7.44	8.15

These data are presented graphically in Figure 51.

Preliminary evaluation of the hourly and daily relationships among pan evaporation, vapor deficit, and wind, shows the familiar empirical form:

Evaporation=(vapor deficit) (a+b wind)
where a and b are constants. Studies are under way to determine the exact relationship of moisture consumption to meteorological factors.

A new water pipeline at the Station will allow

the installation of the sugarcane cover on the third lysimeter.

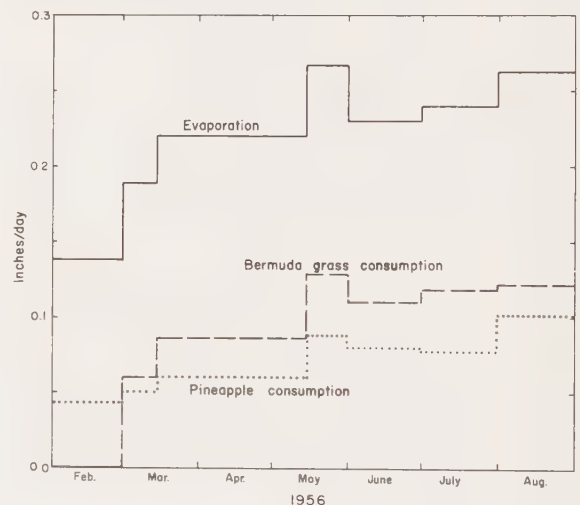


Figure 51. Moisture consumption at PRI Waipio Field Station.

TEMPERATURE MAIN FACTOR IN MOVING PLANT CARBOHYDRATES

Four plants were selected from four climatic conditions as follows:

Plant No.	Air Temp.	Root Temp.	Light Intensity
1	Makiki	73° F.	Full
2	"	73° F.	Half
3	"	60° F.	Full
4	—18° F.	73° F.	Full

The fifth leaf of each plant was fed radioactive C14O₂ at 9:00 a.m. Leaf punches were taken immediately after for initial total photosynthate and subsequent samples taken at the times shown in Figure 52. Note that by 3:00 p.m. the same afternoon, in warm air and full sun, most of the photosynthate had left the fed leaf. Cutting the light in

RC 56: LOSS OF C14 FROM FED BLADE.
PERCENTAGE OF ORIGINAL COUNTS
IN FOUR LEAF PUNCHES.

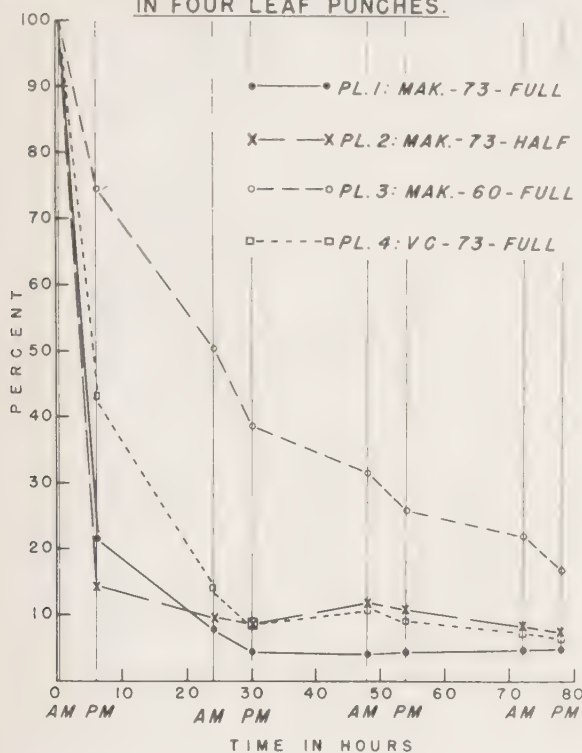


Figure 52.

EFFECT OF AIR TEMPERATURE ON
GROWTH WITH AND WITHOUT SHADE.

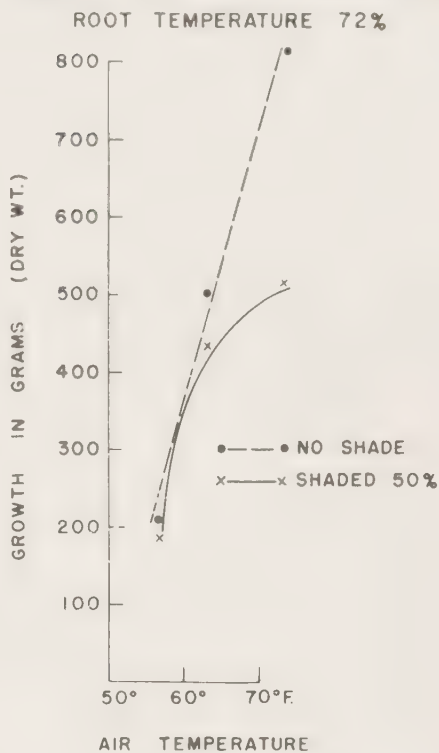


Figure 53.

half had little effect on movement of carbohydrates from the leaves. On the other hand, temperature had large effects. Cold air reduced the movement from the leaves considerably during the first 24 hours. But cold roots exerted the striking effect.

Translocation must be considered a part of a general circulatory system which goes through the roots. When root activity is reduced by low temperature (60°F.), high stem and leaf temperature is ineffective in carrying away the photosynthate.

TEMPERATURE AND LIGHT CONTROL WATER CONSUMPTION AND GROWTH

The air-conditioned house continues to produce valuable information about the effects of temperature and light on growth, water consumption and tissue composition.

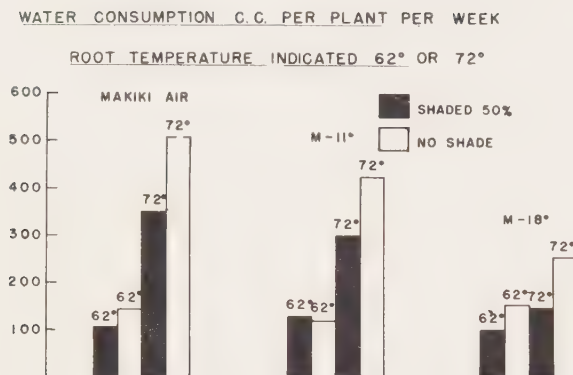
An additional treatment was added by installing slat shades which reduce light to 50 per cent of full daylight. This, in combination with three air temperatures and four root temperatures, makes possible 24 climates running simultaneously with four replications each.

Figure 53 shows that with adequate root

temperature (72°F.), gain in weight is proportional to air temperature in the range from 56° to 74°F. in high light intensity. When the light is cut in half, the response falls rapidly between 63° and 74°F., and light becomes the principal limiting factor at the higher temperature. Temperature coefficients of growth are high in climates cooler than Makiki.

Figure 54 shows the water consumption by plants in 12 climates: two root temperatures, three air temperatures and two light intensities. With

Figure 54.



adequate root temperature, added light increased water consumption about 50 per cent, while raising air temperature 18°F. doubled it. Root temperatures of 62°F. completely controlled water consumption and held it at a constant level regardless of air temperature and light intensity.

Figure 55 shows a most striking effect of tem-

ROOT AND AIR TEMPERATURE EFFECTS ON CONCENTRATION OF REDUCING SUGARS IN THE 8 TO 10 NODES (EXPRESSED AS % DRY WT.)

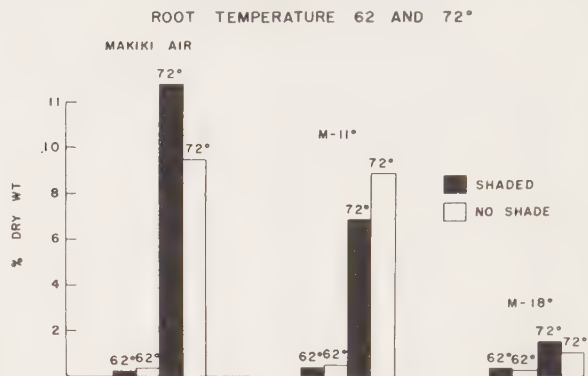


Figure 55.

peratures on composition. With warm roots (72°F.), reducing sugars in the 8-10 internodes decrease rapidly with falling air temperature. With cold roots, reducing sugars are reduced to a trace completely independent of air temperatures. These observations probably have a bearing on seasonal changes in juice quality.

WEED CONTROL

INHIBITORS OF CORROSION PROTECT AGAINST FERTILIZER SOLUTIONS

A new inhibitor of corrosion, developed in the latter part of 1955 and known as "Inhibitor 6B", has been under study for about 10 months. It was designed to meet a situation which appears to be developing throughout the world as a result of the outstanding advances made in the synthesis of new chemical compounds in petroleum chemistry. One of the practical developments accruing from this research will probably be an entirely new line of concentrated liquid fertilizers.

One of the problems which has slowed down the appearance in commerce of large quantities of these fertilizers is the difficulty of controlling corrosion in shipping these liquids in bulk, in storing them, and in applying them in the field.

Many Hawaiian plantations are now employing aqua ammonia and solutions of muriate of potash as fertilizers. One of the deterring factors in using the muriate solution has been its excessively corrosive effect on iron, steel, and most common metals. Ammonia is destructive to some of the non-ferrous metals, such as aluminum, zinc, copper, and brass. Where liquid ammonia and concentrated solutions of muriate of potash are delivered to dock installations throughout the Territory in separate tanks, there is no severe problem of corrosion when ammonia is stored and handled in equipment consisting of black iron or steel plate. Hence, it is not necessary to use stainless steel as far as ammonia is concerned. In the case of muriate of potash, even stainless steel will not resist the corrosive attacks of this chemical fertilizer.

However, it has been found in the laboratory that mixtures of equal volumes of ammonia and a 2.5 pound-per-gallon solution of muriate of potash will exert some, but remarkably little, corrosive effect for a day or more on ordinary black iron or steel.

Further studies with this mixture indicate that, when ordinary iron or steel tank trucks are used to haul the bulk solutions to infield mixing stations, alternate delivery of muriate and ammonia solutions might prove advisable. When the ammonia solution is the last load delivered at the end of the day to the infield station where the final mix is being made, the free ammonia remaining in the empty tank truck seems to retard severe corrosion temporarily. Therefore, it might be found advantageous to fill an iron or steel truck with the ammonia solution during the period that it is idle.

In view of the fact that storage and spraying equipment sometimes include parts, such as outlets, pipe and other fittings, which may consist of aluminum, galvanized iron, or brass, but not copper, the addition of Inhibitor 6B to the mixture of muriate of potash and aqua ammonia will definitely retard its corrosive and deteriorating effect. Furthermore, if the unusually destructive and highly corrosive solution of calcium nitrate were to be used in the Territory, the addition of up to one per cent of Inhibitor 6B will definitely arrest attack by this calcium fertilizer on common iron and steel.

SILVEX NOT CLEARED FOR COMMERCIAL USE

Experimental studies with Silvex by the Department of Agronomy and plantation men have indicated that it may prove advantageous to add this chemical to the list of effective herbicide compounds. Silvex carries, in one chemical setup, the

components of dalapon and 2,4,5-T. While it is true that the essential equivalents of these two components have been cleared for use on food products, Silvex itself has not been so cleared. One reason for this delay is most probably due to the

fact that the compound has not been patented by any one manufacturer. Furthermore, as it may be obtained from three different mainland producers, it does not seem likely that any one of them will

put up the entire cost of clearing it. The clearance of the compound would have to be undertaken by the Experiment Station in cooperation with one or all of the manufacturers.

IMPROVED MCP BEING SCREENED

MCP, methyl chloro phenoxyacetic acid, is similar to 2,4-D, differing only in that the chlorine in the 2-position in the ring has been replaced by a methyl group, with the reputedly more active chlorine remaining in the 4-position.

A new and improved MCP is now being manu-

factured by a mainland chemical concern.

Screening studies at this Experiment Station indicate that the new compound is indeed an improvement over the older product. The latter, when previously screened, proved to be ineffective.

CPA KEEPS INSOLUBLE HERBICIDES IN SUSPENSION

The use of CPA, a carboxy polymerized acetate, as an effective dispersing agent for micronized, insoluble herbicide powders, such as CMU, DCMU, etc., has been developed at this Experiment Station. This compound has also been found effective as a dispersing agent in mixtures of CADE, water, and DCMU. Research in simplifying the processing of CPA and its utilization in the field has been in progress for about 18 months. This research has been continued because CPA is indeed an excellent dispersing agent, even at concentrations as low as 1/20 of one per cent in the final spray mixture. CPA imparts to the suspended insoluble powder a quality it does not normally possess; namely, the individually suspended particles treated with CPA resist cohesion and do not cake in the water mixture. Without this additive, the suspended CMU particles will fall to the bottom of the container and in a short time form a rather stiff and hard cake which is difficult to resuspend. In the presence of CPA, cohesion of CMU particles and the formation of a hard cake definitely do not take place, although a soft, feathery settling does occur at very low concentrations of CPA. This settling, however, is readily dispersed again by very slight agitation.

On the other hand, where the concentration of CPA is raised to 0.3 or to 0.5 per cent, the suspension persists, without any settling whatever, for a matter of days or even months.

Spray applications with water suspensions of CMU and DCMU containing CPA or colloidal borax have shown the following:

1. With the addition of 0.1 per cent CPA or colloidal borax to the mix in water, neither CMU nor DCMU will form a hard aggregate in the bottom of the container after a period of settling as they do when dispersed in water alone. Only slight agitation is necessary in the spray equipment to ensure a homogeneous suspension of either CMU or DCMU.

2. When applied by pressure knapsack, the agitation of motion is sufficient to keep the herbicides, dispersed in either CPA or borax, adequately suspended.

3. If the mix is to be applied by airplane or tractor, the addition of CPA or borax will allow for pre-mixing and storage. It prevents plugging of nozzles when the spray unit is stopped for a period of time. It also makes possible immediate reagitation and complete suspension of the herbicide when spraying is resumed.

EMULSIFYING DALAPON IN AN AROMATIC OIL

The need for a dalapon and aromatic oil emulsion was suggested by the Department of Agronomy, its purpose being to combine the grass-killing properties of dalapon with the over-all

herbicidal activity of aromatic oil to form a closely-adhering and penetrating film when sprayed on the vegetation. One disadvantage which was found in using this mixture was the marked tendency

of the emulsion to break, with the separation of the oil and aqueous phase.

The Department of Chemistry is resuming research in the development of a new emulsion of these two herbicides, employing one of several new types of emulsion stabilizers which are now becoming available and which, the manufacturer claims, will permit the preparation of such an emulsion even in the presence of an appreciable amount of electrolytes.

A formulation of sodium dalapon in an emulsion with aromatic oil was tested in several loca-

tions by the Agronomy Department. The results have varied, but in general have shown that the dalapon is absorbed by Bermuda grass, rice grass and the crab grasses rapidly enough to offset the contact effect of the oil. Even though leaves of these grasses may be destroyed by the oil, still the dalapon effect on the grass is rapid and nearly equal to the over-all effect of dalapon in water solution. In addition, broadleaved species are destroyed by the aromatic oil in the emulsion. Slight contact effect of dalapon in water has been noted on some broadleaved species.

NEW CHEMICAL HERBICIDES LESS NUMEROUS

During 1956, a marked lull has occurred in the appearance of new chemical herbicides offered by mainland manufacturers. There are two reasons for this: first, because of governmental herbicide control legislation under the Miller amendment, it is necessary for a manufacturer to spend up to \$50,000 to develop a new herbicide chemical, prove its value in his own laboratory, greenhouse, and field plots, distribute it to other experiment stations and investigators throughout the country, and finally, prove from analysis of any possible residues in the soil and crop, and by extensive biological studies in his own organization, that the product may be used upon weed growth in food crops without any danger of injury to humans or to animals; and second, because of the fact that there are now available seven basic chemical compounds which embrace all of the needed requirements of modern weed control procedure. These include pre-emergence as well as post-emergence compounds, hormone-type herbicides having low volatility, specific grass killers, a synergetic compound which activates contact killers, selected herbicides peculiarly adaptable to broadleaf weed control, etc. As a consequence, any new compound which may be found worthy either of being added to the present group or of supplanting any one of them, would indeed need to be a product of unusual superiority.

Among the few new compounds appearing this year, there are two which are worthy of mention. One is Neburon. This compound is 1 N butyl-3, 3, 4-dichlorophenyl-1-methyl urea. It is a com-

panion product of Karmex W and Karmex DW. The manufacturer has found it effective in controlling the growth of chick weed and crab grass in grass turf or in lawns without apparently having any damaging effects upon wanted grass. Neburon is a compound having very low solubility. It is marketed as a micronized powdered mixture containing 18.5 per cent of the active chemical. Its application in the field is made by suspending it in water. Its value under Hawaiian conditions as a pre-emergence or contact compound will be determined. The Agronomy Department has inaugurated experimental field studies on the behavior of Neburon.

Another new compound, which is a modification of 2,4-D, will soon be available for experimental study in Hawaii. It is known as tris-2,4-dichlorophenoxy ethyl phosphite. This compound is naturally a syrupy liquid having an oily consistency and is soluble in the oils used in herbicide work. This may prove to be an advantage in emulsifying compounds for field application. From a study of its chemical structure, it appears likely that this new modification of 2,4-D will probably have no injurious effect upon the foliage of hormone-sensitive vegetation growing in the vicinity where it may be applied. Samples of this compound are due shortly, and the Department of Chemistry will immediately inaugurate research to ascertain its properties and whether it may be processed readily on the plantation. This work will be carried out in cooperation with the Department of Agronomy.

FIELD SCREENING STUDIES WITH NEW HERBICIDES

In the field screening of herbicides, the following chemicals were tested:

CDAА (Radox).

(chloro-N, N-diethylacetamide)

In several tests this compound was found to give pre-emergence control about equal in number of days to 2,4-D when applied either combined with aromatic oil or diluted in water.

CDEC.

(2-chloroallyl diethyldithiocarbamate)

This compound was about equal to CDAА in number of days' control given when tested on pound-for-pound basis. In a few tests, it exceeded the CDAА by a few days.

Either CDAА or CDEC may have some value as substitutes for 2,4-D in areas where 2,4-D is in restricted use. Their oral toxicity to test animals is about the same as 2,4-D's. Either compound may cause some skin irritation, but this is temporary in nature. Volatility studies and tests of the effects of these compounds on garden crop plants are planned before recommendations for use are issued.

Amino triazole

This compound has the effect of destroying chlorophyll in the plants. Sugarcane plants are affected by as little as one pound per acre. Consequently, it is believed that this chemical should not be in general use in sugar cane. The amino triazole has shown good control of nut grass and field sedge, as well as some lesser control of a species of wild lilikoi. Its value is shown in special-

ized control of species of this sort that are common only in certain areas. Combinations of amino triazole with dalapon and with TCA have been tested. In some tests, a combination of one pound of amino triazole with two and one-half pounds of dalapon has been as effective on grass as five pounds of dalapon. Present prices of amino triazole would make the over-all cost at the above rates higher for the combination than for dalapon alone.

Comparisons of 2,4-D, 2,4,5-T and Silvex

In a few tests, the BEP, PGBE, and BE esters of 2,4-D, 2,4,5-T, and Silvex, were compared for pre-emergence control. The iso-octyl ester was substituted for the BE ester of Silvex. The results from Test 49.40 at Waialua were:

Chemical	Lbs/A	GPA	No. Days Control
2,4-D BEP ester.....	5.0	25	31
2,4-D PGBE ester.....	5.0	25	33
2,4-D BE ester.....	5.0	25	33
2,4,5-T BEP ester.....	5.0	25	38
2,4,5-T PGBE ester.....	5.0	25	29
2,4,5-T BE ester.....	5.0	25	35
Silvex BEP ester.....	5.0	25	40
Silvex PGBE ester.....	5.0	25	35
Silvex Iso-octyl ester.....	5.0	25	32
CMU + CPA.....	5.0	25	38
DCMU + CPA.....	5.0	25	84
Check	---	---	21

These data show only slight differences between forms of ester for each chemical. The periods of control obtained from the Silvex esters were longer but not outstandingly so. The period of control given by DCMU in this test was greatly superior to that given by CMU.

HAVE YOU SYMPTOMS OF HERBICIDES ON SUGAR CANE?

More symptoms of herbicides on sugar cane have been observed in plantation fields this year than in any year since the organic herbicides were first used. These include symptoms of 2,4-D esters, dalapon, CMU and DCMU. In most cases, these are symptoms of over-application due to the method of operating spray equipment, infield mixing of CMU, porous soil effects, and too much spraying of systemic materials on cane leaves.

In order to help identify the symptoms caused by the different herbicides sprayed over sugarcane leaves, a test was set up at the Waipio Substation

in which 20 pounds per acre of dalapon, TCA, 2,4-D ester, 2,4,5-T ester, Silvex ester, CMU, CMU+CPA, DCMU, and BDCMU, were sprayed over plants of the varieties 37-1933, 38-2915, and 44-3098. The effect of each herbicide on 37-1933 is illustrated in Figures 56 to 64.

There were no outstanding differences in the varietal reactions to the several herbicides. As a general observation covering all of the herbicides, 38-2915 appeared to be the most vigorous of the three varieties, 37-1933 seemed the least vigorous, with 44-3098 intermediate.



Figure 56. Dalapon.



Figure 57. TCA.



Figure 58. 2,4-D.



Figure 59. CMU.



Figure 60. CMU + CPA.



Figure 61. 2,4,5-T.



Figure 62. DCMU.



Figure 63. BDCMU.



Figure 64. Silvex.

Figures 56-64. All herbicides were applied at the rate of 20 pounds per acre.

Evaluation of Herbicidal Effects on Variety 37-1933

	Dalapon	TCA	2,4-D BEP Ester	2,4,5-T BEP Ester	Silvex BEP Ester	CMU	CMU + CPA	DCMU	BDCMU
Cane index.....	3.5*	1.5	3.5	2.5	2.5	2.0	1.5	1.5	1.5
Leaf burn.....	4.0	3.0	4.0	4.0	2.0	2.0	3.0	2.0	1.5
Leaf mottling.....	3.0	1.5	1.5	3.0	1.5	4.0	3.0	2.0	2.0
Tops.....	Tangling at Tips	1.0	Reduced Several Dead	Nearly Normal	Slightly Reduced	Slightly Reduced Leaves Rolled	Near Normal	Near Normal	
Stalk.....	3.0	1.0	4.5	3.0	2.0	3.0	2.0	1.5	1.5
Tillering.....	3.0	1.0	4.0	3.0	3.0	2.0	2.0	3.0	2.0
Root index.....	4.5	2.0	4.5	3.5	3.0	3.0	2.5	2.5	2.5
Old roots.....	4.0	3.0	4.0	4.0	4.0	2.0	2.0	2.0	4.0
New roots.....	4.0	4.0	4.5	4.0	4.0	4.0	1.0	1.0	1.0
Variety grade.....	—	=+	—	=—	=	=	=+	=+	=
General growth.....	4.0	1.0	4.5	2.0	2.0	2.0	1.5	1.5	1.5

* Key to Index

Index.....	1.0	1.5	2.0	3.0	4.0	5.0
Condition.....	Normal	Trace	Slight	Moderate	Severe	Plants dead or dying

Although chlorotic mottling and dead roots were some of the symptoms of the herbicides, a

trace of mottling and some dead roots were also found in the checks.

CMU HAS NO EFFECT ON YIELDS AT LIHUE

A yield test, studying the effect of varying amounts of CMU applied in variety 44-3098 in the first ratoon at Lihue, has shown no yield reduction from this herbicide applied in amounts from five to 20 pounds per acre in single and split

applications. This information indicates that at the levels presently used at Lihue, there is little, if any, danger of damage to the crop even with doubling of amounts in overlap areas. This test also showed no yield reduction in the plant crop.

EFFECT OF HERBICIDES ON CROP PLANTS WATCHED

Station herbicide specialists have cooperated with the Territorial Board of Agriculture in observing the effects of 2,4-D, 2,4,5-T and Silvex

on macadamia nut trees, and CMU and DCMU on Chinese cabbage, celery and tomatoes. Symptoms at various concentrations were studied.

EVALUATION OF HOSES, PLASTIC COATINGS AND METALS FOR HERBICIDES, FERTILIZERS AND SOIL FUMIGANTS

Numerous samples of rubber hoses and plastic pipes have been tested for resistance to aromatic oil, alone and with PCP, diesel oil, TCA, aqua ammonia, aqua potash, DD and EDB (ethylene dibromide). Several of these have proved satisfactory for the herbicides and fertilizers but not for the soil fumigants.

Tests with plastic coatings have shown that the epoxy resins, polyester resins, and vinyl chloride, as well as Koroseal, give good resistance to potash

solutions and the herbicides, including TCA and the aromatic and diesel oils. Vinyl chloride becomes soft rapidly in contact with DD and EDB.

Black iron has proved satisfactory for fabrication of equipment for aqua ammonia. Coatings for lining aqua ammonia tanks are unsatisfactory, since the aqua ammonia liquid or fumes will cause separation of the coatings from the metal.

Number 316 alloy of stainless steel has proved the most resistant to corrosion by potash and TCA.

Figure 65. Oahu Sugar's new infield supply tank can recharge spray gang knapsacks in the field from its hoseline.



This material should be fabricated with a welding rod of the 25-20 type. Stainless steel plates welded with this rod showed less corrosion after one year

of contact with muriate of potash crystals than those welded with 18-8 or 19-9 stainless steel welding rod.

PLASTIC COVERING OF FOOTWEAR PROTECTS AGAINST AROMATIC OIL

A cooperative test, now in progress at Pioneer Mill, was set up by that plantation, Gaspro, Limited, and this Station, to evaluate epoxy and polyester resins, silicone and vinylidene chloride, for protecting leather and rubber boots against the destructive effects of aromatic oil.

When these materials had dried on the leather boots, the epoxy resin and the vinylidene chloride

completely shed the oil. The silicone-treated leather boots still absorbed some oil.

After two weeks of use by a spray gang, rubber boots covered with epoxy resin were in better condition than untreated boots. The leather boots were still shedding the oil, but had hardened noticeably, even to the point of causing some blistering on the spray men's feet. The test will be continued.

TIME-LAPSE AND SEQUENCE PHOTOGRAPHY RECORDS HERBICIDE EFFECTS

The Department of Agronomy is cooperating with Ewa in taking time-lapse and sequence movies of soils treated for pre-emergence control of weeds, and of grass plants treated with systemic herbicides. These movies will show the action of herbicides on plants over periods of from two

weeks to 100 days, the entire action being shown on a screen in a few minutes. One frame of the time-lapse movies is taken every 15 minutes, and the sequence shots are taken every one, two or three days, as needed, to record chronologically the reaction of the treated plant to the herbicide.

NEW INFIELD SUPPLY TANKER AT OAHU SUGAR COMPANY

An infield supply tanker fabricated in the Stuenberg shop in Honolulu was recently placed in operation by Oahu Sugar.

The unit has a partitioned tank with two 900-gallon compartments that may be operated in-

dependently or as a unit of 1800 gallons. This supply tanker is a self-contained unit for charging pressure knapsacks where the spray gang is working infield up to a distance of 1500 feet (Figures 65 and 66).



Figure 66. A spray gang uses new stainless steel pressure knapsacks with three-nozzle booms to apply CADE and 2,4-D.

SPRAY EQUIPMENT BEING IMPROVED

Improvements are being attempted on low-pressure nozzles used on spray equipment which, by preventing formation of small droplets that will readily drift with the wind, will make them safe for use in 2,4-D restricted areas. These are called sprinkler nozzles, and have been tested for both tractor and spray gang use. They are operated at pressures of from five to 10 pounds per square inch and may be used with only gravity flow from pump-type knapsacks. Some infield spraying with this type of equipment has been done satisfactorily at Hamakua, Hutchinson Sugar Company, Ltd., and Paauhau. Units are being tested at Wailuku. In the design of new equipment for plantation use, including infield supply units, knapsacks and spray tractors, the Agronomy Department has consulted with plantation personnel and fabricators.

The performance of equipment thus recommended and prepared has shown that strainers are needed at several locations in the spray solution line from the mixing plant to the nozzle in the field. For this purpose, .020-inch-mesh woven

wire screen should be used at the following locations:

1. A large basket screen, at least five inches in diameter by 24 inches deep, in the filler opening on every supply tanker, so installed that it is protected against crushing by liquid sloshing in the tanks. It should be readily removable for cleaning, but the Weed Control Supervisor should insist upon its continued use to prevent the entrance into the tank of any substance that is too large to be dispersed through the nozzle in the field. A similar strainer should be in the supply tank on every spray tractor.
2. A readily flushable sump on the intake line to the pump. This may, but need not, contain a strainer.
3. A tee-type strainer with flush-cock at the bottom on the pressure side of the pump.
4. A readily removable strainer in the handle on the spray gun of each knapsack.
5. A strainer in every nozzle on the spray gun or tractor boom.

CAN CANE FOLIAGE BE SUCCESSFULLY DESICCATED FOR RIPENING?

Studies have been continued at Olaa into possibilities of desiccating cane leaves by chemicals or by burning after plants have been grab harvested and piled. Five chemicals were tested for their

effect on ripening. Several chemicals recently obtained are currently being tested for their effect on drying the leaves.

A test was made with a "Rotomist" sprayer

mounted on a truck along the roadside to apply chemical desiccants and also to apply oils as an aid to flaming during the burning period. The unit was not considered satisfactory because of the limited area that can be covered from infield roads. Aircraft are about the only satisfactory dispersing agent for this purpose.

One study was made of the use of antibiotics and other chemicals to protect stalks and juices of unburned cane against deterioration for several days after it has been grab harvested and piled in rows. Burning was done 10 days after harvest when the leaves had dried. Juice data indicate that agrimycin, formaldehyde, and terramycin may have had an effect in preserving juice quality for

six days. There was little change in the checks at three days. Although the cane was not burned until the tenth day, the leaves were noticeably dry on the fourth day and might have been burned at that time. Controlled burning of cane following harvest has distinct possibilities, and further testing of the antibiotics and formaldehyde is warranted.

In a test with chemicals for determining their effect on ripening of sugar cane at Olaa, 2,4-D, dalapon, amino triazole, CMU, and maleic hydrazide were applied at 20 pounds per acre over the plants before harvest. Juice samples were taken at 18 days and 35 days after treatment. None of the chemicals applied produced any appreciable change from normal in juice quality.

YIELD DECLINE INVESTIGATIONS

CROP ROTATION WITH PINEAPPLES INCREASING

Crop rotation of sugar cane with pineapples continues to show benefits to both crops. Expansion of acreage under rotation by Lihue with Hawaiian Canneries Company, Ltd., was continued in 1956. Several hundred acres of land are now under rota-

tion at Grove Farm as well as at Lihue plantation.

The addition of approximately 80 tons of pineapple trash per acre, on a green weight basis, improves the physical, chemical and biological status of windward Kauai soils, and increases yields.

YIELD DECLINE TESTS HARVESTED

The two Grade A experiments installed on Oahu and Hawaii in 1954 were harvested in April and June 1956, respectively. The tests were designed to determine (1) if sugar yields from H109 and 32-8560, which have shown decline, can be brought back, and (2) if sugar yields from 37-1933 and 44-3098, which have shown no decline, can be maintained over a period of years by the addition of organic matter and/or by soil fumigation. The treatments were as follows:

1. Check
2. Compost
3. Fumigation (DD at 40 gallons per acre

plus Chlordane at 5 pounds per acre)

4. Compost plus fumigation

The fertilization was uniform to all plots as based on monthly foliar and stalk analyses. Disease-free planting material for each test was grown at Waipio Substation from LHWT cuttings so as to eliminate ratoon stunting disease as a limiting growth factor. The experiments were harvested by the slash-cut method, by hand at Oahu Sugar and by the Duncan cutter at Hamakua. Yield data from the various treatments, obtained from the center six rows of each plot by the pol ratio method, were as follows:

OAHU SUGAR COMPANY, LTD.

Age 23 mo. Fertilization lbs. p.a. 350-N, 400-P₂O₅ and 350-K₂O.

		x	Compost	Fumigation	Compost + Fumigation	All Treatments Combined
H 109.....	TC/A	106.0	104.8	112.4	110.2	108.3
	TC/TP	7.1	7.0	7.5	7.5	7.3
	TP/A	14.9	14.8	15.0	14.7	14.8
37-1933.....	TC/A	129.9	140.0	137.2	146.4	138.4
	TC/TP	7.0	7.0	7.1	7.4	7.1
	TP/A	18.6	19.9	19.4	19.9	19.4

HAMAKUA MILL COMPANY

Age 22.3 mo. Fertilization lbs. p.a. 324-N, 390-P₂O₅ and 484-K₂O.

		x	Compost	Fumigation	Compost + Fumigation	All Treatments Combined
32-8560.....	TC/A	84.0	85.3	105.1	109.4	95.9
	TC/TP	7.2	7.1	6.9	7.4	7.1
	TP/A	11.7	12.0	15.1	14.9	13.4
44-3098.....	TC/A	112.6	112.0	119.5	122.1	116.5
	TC/TP	8.2	7.8	8.5	8.4	8.2
	TP/A	13.7	14.2	14.1	14.5	14.1



Figure 67. The three pots at the left show the growth response of 32-8560 in fumigated (DD) soil from check plots of the Hamakua yield decline test. The three pots at the right show growth of the same variety in similar soil which has not been fumigated.

SUMMARY OF RESULTS

1. Yield differences due to compost were not significant.

2. The increase in TPA due to fumigation was not significant for H109, 37-1933 and 44-3098.

3. The variety 32-8560 showed a marked response to fumigation (3.4 TPA) over the check plots.

Both tests are being ratooned. One-half of each plot has been fumigated with EDB at the rate of eight gallons per acre in order to study the effect of post-plant fumigation on sugar yields of each variety.

The cause of yield decline appears to be largely biological in nature, and it is likely that the yielding ability of a variety is affected only after certain groups of harmful organisms reach certain populations. In the case of 32-8560, such organisms were present and were reduced in numbers by fumigation to permit the variety to make a superior growth over the check plots. Such was not the case with the other varieties. In the plantation nematode survey, the Hamakua test area showed high counts of parasitic nematodes, whereas in the Oahu Sugar test area, counts were low.

POT TESTS CONFIRM HAMAKUA FIELD RESULTS

In pot studies at the Pathology Plot, 32-8560 has made a much greater growth in fumigated (DD) soil from check plots of the Hamakua Yield Decline test than in similar soil not treated

(Figure 67). In the fumigated soil, nematodes were greatly reduced and fewer fungi and bacteria were found, as determined by extraction and plate count techniques.

TRAINING OF PERSONNEL

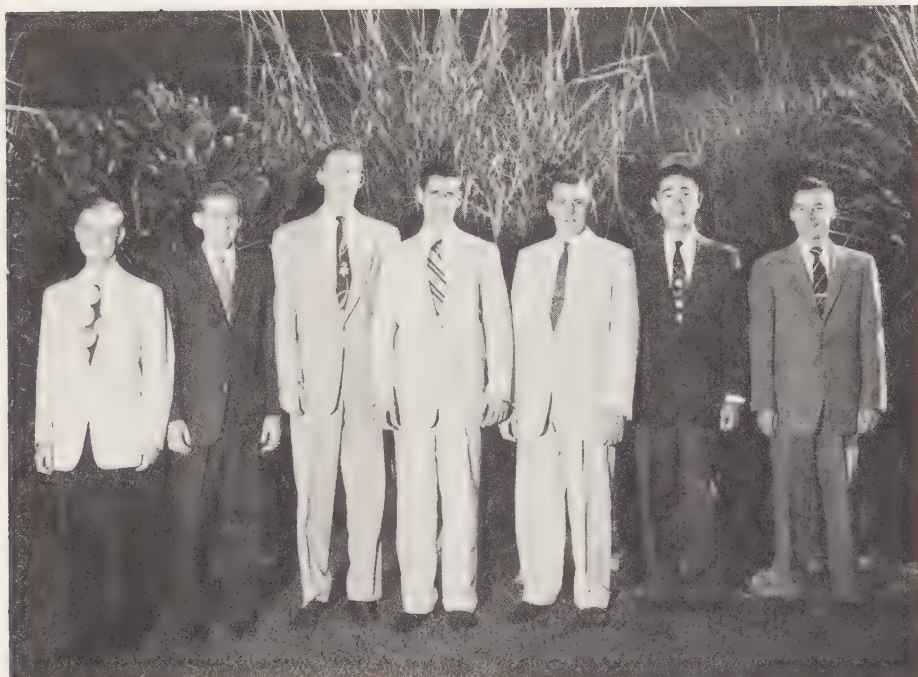


Figure 68. Assistants-in-Training for Agriculture: M. O. Sheets, Jr., Dunrith Waund, Jr., C. E. Warner, A. G. Shura, J. P. Keppeler, Jr., J. M. Sakuma, D. W. Davis.



Figure 69. Assistants-in-Training for Sugar Technology: J. W. Carlyle, G. B. Fraser, H. D. Meyers, R. F. O'Shaughnessey.

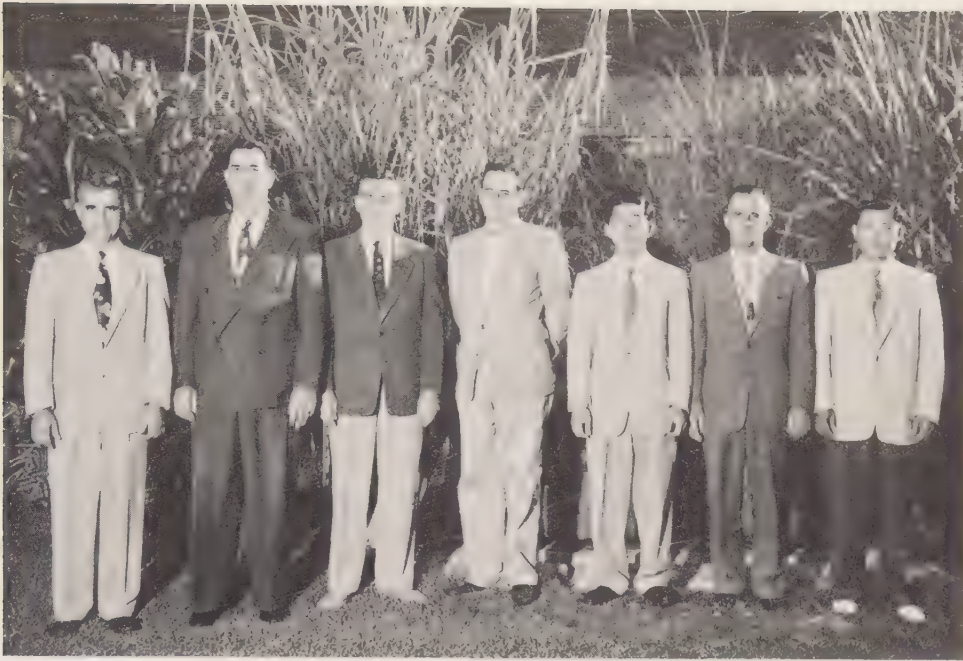


Figure 70. Plantation Trainees for Agriculture: Victor Martins, K. C. Ross, C. A. Carlson, L. J. Costa, Albert Togikawa, William Baptiste, Sadao Inazu.

EXPERIMENT STATION STAFF

September 30, 1956

ADMINISTRATION

L. D. BAVER.....Director H. L. LYON.....Consultant

Business Office

A. R. GRAMMER.....Senior Office Manager F. WM. LITTLEJOHN.....Associate Office Manager

Publications and Visual Aids

L. D. BAVER.....Editor LYDIA C. NICKERSON.....Associate Editor
R. J. LEFFINGWELL.....Consultant J. T. YAMAMOTO.....Photographer and Illustrator

Library

CHARLOTTA M. HOSKINS.....Associate Librarian JEAN DABAGH.....Assistant Librarian

Buildings and Grounds

WILLIAM SA NING.....Superintendent

Island Representatives

HAWAII

O. H. LYMAN.....Senior Island Representative
K. KUNIMITSU.....Assistant Island Representative
A. SATO.....Substation Overseer
H. MIYAMOTO.....Substation Assistant
H. OBA.....Substation Assistant
Y. SUGAWARA.....Substation Assistant

OAHU

F. C. DENISON.....Senior Island Representative
B. K. NISHIMOTO.....Substation Overseer
J. BUMANGLAG.....Substation Assistant
L. NAKATSUKA.....Substation Assistant
H. SAKAI.....Substation Assistant

KAUAI

D. S. JUDD.....Senior Island Representative C. G. SUERO.....Substation Assistant
Y. INOUE.....Substation Overseer A. T. TOGIKAWA.....Substation Assistant

AGRONOMY

R. P. HUMBERT.....Principal Agronomist
A. S. AYRES.....Senior Agronomist
R. B. CAMPBELL.....Senior Agronomist
N. S. HANSON.....Senior Agronomist
A. H. CORNELISON.....Associate Agronomist
R. E. DOTY.....Associate Agronomist
A. C. TROUSE, JR.....Associate Agronomist
H. HAGIHARA.....Assistant Agronomist

T. A. JONES.....Assistant Agronomist
J. A. SILVA.....Assistant Agronomist
Y. YAMASAKI.....Assistant Agronomist
H. ASATO.....Agronomy Assistant
A. Y. CHING.....Agronomy Assistant
GERALDINE KAU.....Agronomy Assistant
G. T. YAMAMOTO.....Agronomy Assistant
M. YAMAMOTO.....Agronomy Assistant

BOTANY

H. L. LYON.....Botanist COLIN POTTER.....Nursery Superintendent

BY-PRODUCTS

G. W. ALJIAN.....Coordinator
T. J. NELSON.....Consultant S. B. KNAPP.....Senior Pulp and Paper Technologist

CHEMISTRY

F. E. HANCE.....Principal Chemist
RICHARD BOYEN.....Executive Assistant GEORGE UYEHARA.....Assistant Chemist
Q. H. YUEN.....Senior Chemist GEORGE KOIZUMI.....RCM Technician
M. DOL.....Associate Chemist HENRY MAU.....Analyst
T. S. JONES.....Assistant Chemist C. T. NAKAGAWA.....Laboratory Technician
H. M. LEE.....Assistant Chemist J. NISHIBUN.....Laboratory Technician
MON YET LUM.....Assistant Chemist E. S. YAMAMOTO.....Laboratory Technician

ENTOMOLOGY

F. A. BIANCHI..... <i>Senior Entomologist</i>	R. E. WARNER..... <i>Assistant Entomologist</i>
J. W. BEARDSLEY, JR..... <i>Assistant Entomologist</i>	J. S. ROSA..... <i>Laboratory Technician</i>

EXPERIMENTAL STATISTICS

J. G. DARROCH..... <i>Principal Statistician</i>	R. K. TANAKA..... <i>Assistant Statistician</i>
--	---

FIELD ENGINEERING

R. A. DUNCAN..... <i>Chief Engineer</i>	E. M. NORUM..... <i>Assistant Project Engineer</i>
E. R. BOLLES..... <i>Senior Design Engineer</i>	G. S. PALMERTON..... <i>Assistant Design Engineer</i>
W. P. BURTON..... <i>Project Engineer</i>	J. H. KIM..... <i>Design Draftsman</i>
W. E. HART..... <i>Project Engineer</i>	P. K. OKAMURA..... <i>Design Draftsman</i>
C. B. HOLTWICK..... <i>Project Engineer</i>	Y. ISA..... <i>Shop Foreman</i>
E. P. MORGAN..... <i>Project Engineer</i>	C. K. MAHOE..... <i>Welder-Mechanic Journeyman</i>
T. ADACHI..... <i>Design Engineer</i>	K. TOGASHI..... <i>Machinist Journeyman</i>
S. KAWAMURA..... <i>Design Engineer</i>	E. T. TORRICER..... <i>Assistant Welder-Mechanic</i>
S. MATSUOKA..... <i>Design Engineer</i>	JOSE GATTUAN..... <i>Assistant Machinist and Storekeeper</i>

GENETICS

A. J. MANGELSDORF..... <i>Principal Geneticist</i>	R. CHI..... <i>Genetics Assistant</i>
J. N. WARNER..... <i>Senior Geneticist</i>	R. IMAMURA..... <i>Genetics Assistant</i>
SAMUEL PRICE..... <i>Associate Geneticist (Coop. USDA)</i>	N. KIMURA..... <i>Genetics Assistant</i>
R. URATA..... <i>Associate Geneticist</i>	A. M. KUBOTA..... <i>Genetics Assistant</i>
A. DOI..... <i>Assistant Geneticist</i>	K. NISHIMOTO..... <i>Genetics Assistant</i>
M. TANAKA..... <i>Supr. Kailua Field Laboratory</i>	H. TERAYAMA..... <i>Genetics Assistant</i>

GEOLOGY

D. C. COX..... <i>Senior Geologist</i>	T. HAYASHI..... <i>Laboratory Technician</i>
--	--

INSTRUMENT SHOP

GORDON FURMIDGE..... <i>Instrument Technologist</i>	G. E. SLOANE..... <i>Consultant</i>
	G. E. LAMBERT..... <i>Instrument Technician</i>

ORGANIC CHEMISTRY RESEARCH

H. W. HILTON..... <i>Principal Organic Chemist</i>	
T. YAMAMOTO..... <i>Assistant Organic Chemist</i>	E. S. KUROKAWA..... <i>Laboratory Technician</i>

PATHOLOGY

J. P. MARTIN..... <i>Principal Pathologist</i>	H. KOIKE..... <i>Assistant Pathologist</i>
C. A. WISMER..... <i>Senior Pathologist</i>	A. S. MIURA..... <i>Laboratory Assistant</i>

PHYSIOLOGY AND BIOCHEMISTRY

G. O. BURR..... <i>Principal Physiologist and Biochemist</i>	ROBERT E. COLEMAN..... <i>Assistant Physiologist</i>
H. W. BRODIE..... <i>Senior Physiologist</i>	(Coop. USDA)
CONSTANCE E. HARTT..... <i>Associate Physiologist</i>	ADA FORBES..... <i>Assistant Physiologist</i>
H. P. KORTSCHAK..... <i>Associate Biochemist</i>	ROBERT M. NAKAMURA..... <i>Laboratory Technician</i>
T. TANIMOTO..... <i>Associate Biochemist</i>	K. M. SADAOKA..... <i>Laboratory Technician</i>
DAVID TAKAHASHI..... <i>Assistant Biochemist</i>	M. E. WIGMORE..... <i>Laboratory Technician</i>

SUGAR TECHNOLOGY

J. H. PAYNE..... <i>Principal Technologist</i>	G. F. B. APPEL, JR..... <i>Assistant Technologist</i>
G. E. SLOANE..... <i>Senior Technologist</i>	F. J. DUPIN..... <i>Scale Inspector</i>
R. K. HAMILTON..... <i>Associate Technologist</i>	A. C. FONG..... <i>Laboratory Technician</i>
TOSHIO MORITSUGU..... <i>Associate Technologist</i>	H. S. IWATA..... <i>Laboratory Technician</i>
L. J. RHODES..... <i>Associate Technologist</i>	W. T. SHIRAMIZU..... <i>Laboratory Technician</i>
CHEN-CHUAN TU..... <i>Associate Technologist</i>	RAY SPELLMAN..... <i>Laboratory Technician</i>

TRAINING OF PERSONNEL

W. P. ALEXANDER..... <i>Principal Coordinator</i>	
---	--

STATION PERSONNEL CHANGES

October 1, 1955 to September 30, 1956

JOINED THE STAFF

W. P. BURTON
J. W. CARLYLE
J. G. DARROCH
D. W. DAVIS
G. B. FRASER
C. B. HOLTWICK
GERALDINE KAU
S. KAWAMURA
J. P. KEPPELER II
J. H. S. KIM
E. S. KUROKAWA
H. D. MEYERS
E. P. MORGAN
G. K. OKAMURA
R. F. O'SHAUGHNESSY
J. M. SAKUMA
W. P. SCHAFER
M. O. SHEETS
J. CHEN-CHUAN TU
MASAICHI UEHARA
C. E. WARNER
R. E. WARNER
DUNRITH WAUND, JR.

Project Engineer
Assistant-in-Training
Principal Statistician
Assistant-in-Training
Assistant-in-Training
Project Engineer
Agronomy Assistant
Design Engineer
Assistant-in-Training
Design Draftsman
Laboratory Technician
Assistant-in-Training
Project Engineer
Design Draftsman
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Associate Technologist
Assistant-in-Training
Assistant-in-Training
Assistant Entomologist
Assistant-in-Training

FIELD ENGINEERING
TRAINING PERSONNEL
EXPERIMENTAL STATISTICS
TRAINING PERSONNEL
TRAINING PERSONNEL
FIELD ENGINEERING
AGRONOMY
FIELD ENGINEERING
TRAINING PERSONNEL
FIELD ENGINEERING
ORGANIC CHEMISTRY
TRAINING PERSONNEL
FIELD ENGINEERING
FIELD ENGINEERING
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
SUGAR TECHNOLOGY
TRAINING PERSONNEL
TRAINING PERSONNEL
ENTOMOLOGY
TRAINING PERSONNEL

LEFT THE STAFF

F. M. ASHTON
G. C. BATTLE, JR.
M. J. CONJUGACION
G. N. FERNANDES
Z. M. FREILANDS
W. T. GOTO
J. H. HEWETSON
WALLACE A. HIRAI
H. HOSHIDE
NOBORU L. IWAMI
E. S. S. LAM
E. D. LYON
H. I. MAHON
C. R. MIDDLETON III
O. R. MOE
J. M. NUTTER
KIYOSHI SADANAGA
J. A. SASAN
W. P. SCHAFER
JOHN W. SIEMER
T. R. SPARROW
W. J. TEMPAS

Assistant Biochemist
Assistant Chemist
Drafting Assistant
Assistant-in-Training
Assistant-in-Training
Agronomy Assistant
Assistant-in-Training
Assistant-in-Training
Assistant Island Representative
Assistant-in-Training
Laboratory Technician
Assistant-in-Training
Associate Technologist
Genetics Assistant
Assistant-in-Training
Associate Agricultural Engineer
Genetics Assistant
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Assistant-in-Training
Associate Agricultural Engineer

PHYSIOLOGY & BIOCHEMISTRY
CHEMISTRY
EXPERIMENTAL STATISTICS
TRAINING PERSONNEL
TRAINING PERSONNEL
AGRONOMY
TRAINING PERSONNEL
TRAINING PERSONNEL
HAWAII SUBSTATION
TRAINING PERSONNEL
SUGAR TECHNOLOGY
TRAINING PERSONNEL
SUGAR TECHNOLOGY
GENETICS
TRAINING PERSONNEL
FIELD ENGINEERING
GENETICS
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
TRAINING PERSONNEL
FIELD ENGINEERING

RETIRED

R. H. VAN ZWALUWENBURG
J. B. MENARDI

Principal Entomologist
Assistant Island Representative

ENTOMOLOGY
OAHU SUBSTATION

ON LEAVE OF ABSENCE FOR MILITARY DUTY

E. S. KUROKAWA
R. E. MOTT-SMITH
J. A. RUSSELL

Laboratory Technician
Assistant-in-Training
Assistant-in-Training

ORGANIC CHEMISTRY
TRAINING PERSONNEL
TRAINING PERSONNEL

